ADP

What is Automatic Coding?

'Only Profits Justify the Investment'

The Anonymous Face of the Investigator

A Game to Improve Sales Executives

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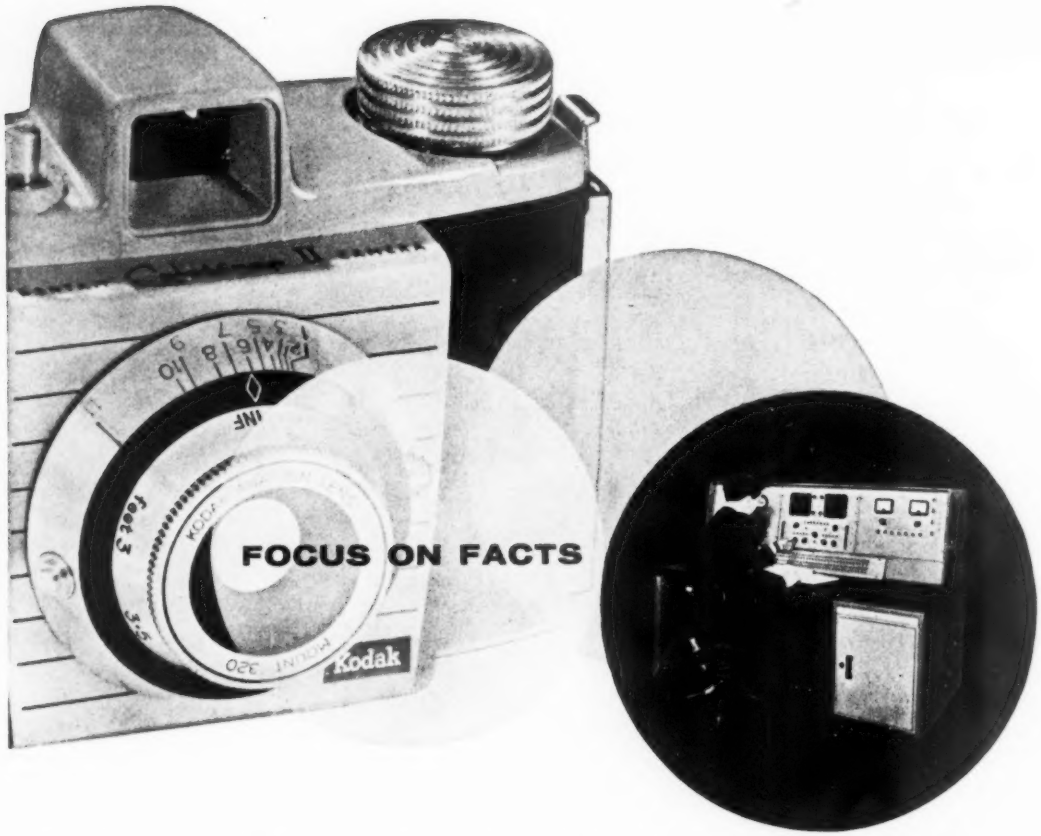

KODAK CHOOSE EMIDEC

Everyone knows Kodak, and the wide range of photographic goods they produce. It is not difficult to imagine the problem involved in maintaining an efficient production and distribution organisation.

To keep pace with an ever-growing demand, Kodak has now ordered an EMIDEC 1100 electronic computer.

Designed and manufactured by E.M.I. Electronics Ltd., the EMIDEC 1100 is a high speed computer, using transistor and magnetic core techniques.

Kodak will use the computer to maintain up-to-date records of stocks held at its nine wholesale branches throughout Great Britain. The EMIDEC will also print out invoices and maintain personal accounts and statistics for each of the organisation's 30,000 customers and trade outlets.

EMIDEC computers have been selected by many other large organisations and Government departments including:

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AUTOMATIC DATA PROCESSING

VOL 2 No 6 CONTENTS JUNE 1960

JOURNAL OF MANAGEMENT AND INFORMATION SYSTEMS

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AUTOMATIC DATA PROCESSING

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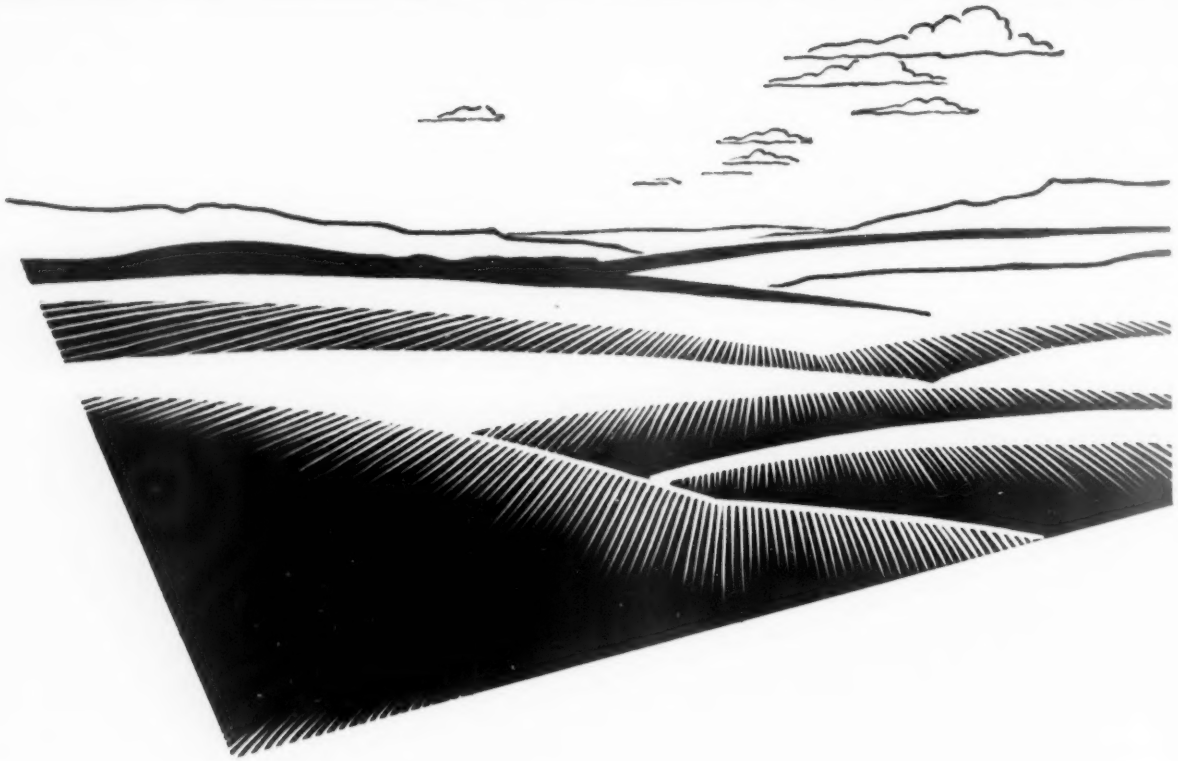

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Comment

Syndicate Talk

'Dad?'

'Yes, Son?'

'Why are you leaving computers?'

'Difficult to say, Son. It's just that I have found other interests.'

'Yes, but what are you going to do?'

'Work for old Cullen of Independent Biscuit.'

'Him! But Independent Biscuit isn't a big company.'

'I'm also going to work for Harper of APT.'

'"Don't buy tin tacks, buy APTacks".'

'That's what their ads say.'

* * * *

'Dad, if you're not going to be a systems analyst any more, what will you be?'

'A trouble shooter, Son.'

'For the two companies?'

'That's right.'

'A member of a syndicate going round probing into how the companies are run?'

'No, just the head of a syndicate.'

'Gee whiz. And Cullen and Harper think their companies are inefficient, do they?'

'No, Son, but they know their directors and managers are too busy to keep up with new techniques and devise organisational improvements.'

'Apart from the fact they both receive orders from retailers, make things, deliver them and get paid, the two companies have nothing in common, and yet Cullen and Harper get together and decide to set up a sort of super O & M syndicate—jointly so as to keep the costs down—to investigate their businesses.'

'That's deduction, Son.'

'And what's more, they decide to hire you to head the syndicate because you've had experience of looking at companies as a whole.'

'That's the look of it.'

'It also looks as if your two friends have been watching with envy what the large companies have been able to do in the way of slicing costs and giving better service.'

'They have, Son.'

'And this syndicate idea is the small man's answer?'

'Yes, Son.'

'Rather like the idea of the two medium-size insurance companies who have decided to own a computer jointly.'

'Something like that.'

'And will this idea catch on, Dad?'

'It hasn't yet, but it might, Son.'

'Cullen and Harper must be rare birds. I suppose you would call them enlightened?'

[*With apologies to Harold Wincott*]

TO BE *well informed on the latest developments* in data processing

think of this

consider this

act on this

The De La Rue Company of Gt. Britain and Compagnie des Machines Bull of France — largest suppliers of computing equipment in Europe — have formed an important new Anglo-French alliance. The new company De La Rue Bull Machines Limited will make available throughout the British Commonwealth a comprehensive and fully proven range of punched card and computer equipment for commerce, industry and research.

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ADP 6

The column for fast access to random information

New Computer starts at £65,000

The new computer that ICT have been hiding up their sleeves to be known as the 1301 is a transistorised and tape, universal machine whose costs might start (for a 'basis' installation) at £65,000 but which (for a comprehensive system with core stores as well as tapes) could well fetch two or three times that figure.

The 1301 has been developed by Computer Developments Ltd, a company set up by the old British Tabulating Machine Company and General Electric, though, of course, ICT who are to sell the system have been in close touch with what has been going on; GEC have contributed the know-how of their telecommunications, electronic and component divisions.

With at least one prototype 1301 undergoing tests in ICT's Putney Bridge House offices, London, it seems that the company have opted for a policy of trying to sell a proved machine rather than to sell 'futures.' (Some details of the new ICT machine are given on page 37.)

Fundamental Change

With a £300,000 price tag

Great things should have happened by 1962 within the Commercial Union Group of Assurance Companies. Commercial Union have slipped into gear and are rolling toward a change in the techniques of insurance organisation and administration as fundamental as the step from pen-and-ledger to typewriters and punched cards.

They engaged first gear with an order for a KDP 10 data processing system which English Electric are currently offering (this is a development of a computer designed by the Radio Corporation of America and it will be built in Britain). This will be delivered to them early in 1962.

It is envisaged that eventually the group's offices all over the country will transmit details of each day's transactions by teleprinter along private land lines to a 'data centre'—a building is being put up somewhere in the south into which the KDP 10 will be wheeled.

Each day the computer will be employed in maintaining a file of some five million policies on magnetic tape, preparing new policies, endorsements, renewal documents and agents' accounts, reconciling cash payments as well as handling day-to-day enquiries.

Apart from assuming the rôle of a monster file, the system will be required to put some of its computing capacity to producing reports to give the management improved control of their business—branch and agents' performance figures, analyses of revenues and claims, and details of outstanding claims will come tumbling out.

Centralising on this scale will require a lot of printing and so two Xeronic printers capable of printing 3,000 lines a minute are to be hooked up to the system. With the possibility of printing 2,800,000 lines a day, presumably the group will have enough slack for expansion?

New Recruit

Store-keeper for the Navy

The Admiralty has added its name to the order book for Emidec 1100's which means that by 1962, at a cost of over £250,000, the naval store depot at Copenacre, Wiltshire, will be recording on magnetised tape the stock records of approximately 90,000 different patterns of stores held there. Also the computer will maintain lists of components for each of some 1,500 different types of radio and asdic sets to be fitted in ships; it will work out complete lists of components needed, look up the stock record and confirm availability, then debit the stock record and prepare printed invoices for the items to be despatched.

Other tasks planned: futuristic work—involving the calculation of future requirements, so that orders can be placed.

Counter Habits

Simulating customers' behaviour

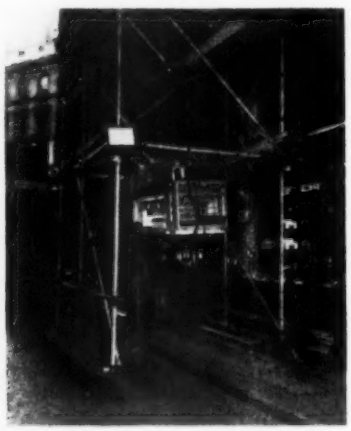
Last year the Postmaster General's committee on 'Conditions and Procedures at Crown Post Office counters' put Associated Industrial Consultants to work to investigate what went on at the counters of the nation's post offices. For 24 weeks the consultants probed into methods of selling postage stamps, motor vehicle licence renewals, etc, how old-age pensioners drew their pensions and the use of automatic stamp machines, then handed over their findings and recommended the GPO should use this information and put it through an electronic computer so as to be able to simulate customers' behaviour and their queueing habits. This the GPO are now doing—using the

computer to devise improvements, based on the operational research findings of the consultants on average lengths of queues, periods of waiting and even movements of customers from longer to shorter queues.

Equipment for the Exchange

Power to its clerical elbow

Up went the scaffolding outside the Stock Exchange building one quiet Saturday morning, then four ICT tabulators and a pair of electronic multipliers were hoisted to the Exchange's fourth floor.



In today, operational in September

Part of a new card set-up, the complete system will be fully operational in the Exchange's Settlement Department by September.

Cranfield Research

Time to buy

A hot-house for post-graduate study in aeronautical science and engineering, Cranfield's College of Aeronautics ran courses in programming and computer techniques but lacked a computer. Now it has decided it is time there was one on the college premises, and has placed an order for a Pegasus machine.

Due to be delivered in July, the computer will come under the ægis of the department of mathematics, while the other departments—design, aerodynamics, flight, electrical engineering, and economics and production—will be able to extend the scope of their research by using the machine.

Two assignments lined up for the machine are for using it in conjunction with automatic recording equipment to form a link in wind-tunnel, engine and flight testing work and for investigations into stock control and accountancy.

Slated against the future: research on information retrieval systems.

Transmission services

From here to eternity

Either because it has followed developments watchfully or because it has been badgered by worried manufacturers, the Post Office has been doing some research into what data collection and transmission services will be needed in the advanced ADP systems of the next few years. Recently 350 organisations were quizzed—through a questionnaire—on their needs, and the replies will be mulled over carefully.

However, in the meantime, the Post Office are presently offering two new facilities for transmitting information:

1—A scheme for transmitting data at the rate of 50 bits a second by using codes other than the standard 'international telegraph alphabet' over the inland telex systems. Where another 5-unit code has to be used, the GPO will modify a customer's normal telex equipment so that the code can be transmitted on punched tape. For codes other than 5-unit ones, a switching device is being developed; this will allow customers' special equipment to be switched in at each end, after a telex call has been set up.

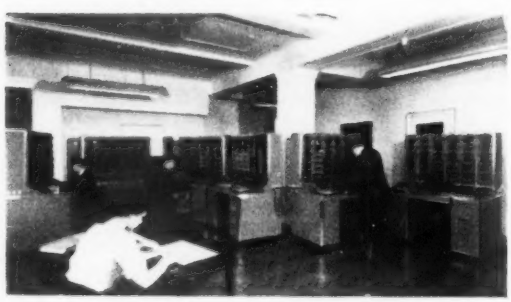
For customers who think the GPO error rate (1 in 40,000 characters) is not good enough, error detection equipment to bring this down to 1 in 100,000 or even 1,000,000 characters is on the way.

General intention, however, is to provide separate sending and receiving units for hire with a hire-tag of £50 to £100 a year permit.

2—From now on data can be transmitted at speeds of up to 600 bits a second over the public network, and in favourable conditions at speeds of up to 2,000 bits a second over private circuits (but still speech-type landlines). However, for the present, users will have to get their own terminal equipment (including line transmission units) commercially and get it approved by the Post Office.

Modulator demodulator units—for converting serial data pulses into a form suitable for transmission and reception over the public network—will eventually be supplied by the GPO on rental terms.

Analogue centre



Recently installed in the Regent Street (London) offices of Short Brothers and Harland Ltd were six general-purpose analogue computers. These, equipped with a wide range of linear and non-linear units, should help meet the demand for analogue computing capacity that the company claim they are receiving from engineers in industry and government

Present Customer

They use telex now

Smaller than the big five, the Bank of Scotland has been able to push ahead with central accounting at a nippy pace. The latest lap was covered when the Oxford Street (London) branch was linked with Edinburgh by hiring an extra telex transmitter; Dunfermline, Glasgow and a number of offices in Edinburgh are already linked by telex to the 'recording centre' to which branch transactions are daily heralded, and converted into punched card entries. The cards are used in an accounting system (king pin: an IBM 421), and in addition to posting on to statements, the system also harvests from the cards new balances, interest calculations and bank charges. After processing, ledger postings and periodic statements are mailed to the branches.

The bank's present equipment is to be superseded by a 1401 computer, so that more branches will be able to come in on the centralised set-up—but that won't happen until 1961.

Campus Computer

Used from different buildings

The Carnegie Institute of Technology has had a computer centre since 1956 which has served as a maid of all work to the faculties and students: many thousand dollars worth of computer time have been worked out for undergraduate and graduate projects. So now Carnegie Tech's centre is thinking bigger and plans to install a Bendix G-20 data processing system in the autumn. Advantages of this new equipment will be that it will compute faster and, as it can be remotely controlled from different buildings on the campus, researchers will be able to use its facilities and get back results without ever putting a foot in the centre.

Glossary

ADP terms defined

With this issue of AUTOMATIC DATA PROCESSING readers are being mailed free our glossary where some 1,200 terms commonly used when discussing scientific and business machines, and automatic data processing generally, are defined. Extra copies of the glossary—the first of its kind from Business Publications. Price 7s. 6d.

Ferranti's research mathematician, Stanley Gill flew to the States recently to start a lecture tour. Invited by leading North American universities, Dr Gill will be talking about 'Atlas,' a new machine built jointly by his company and Manchester University

◀ For M L Jofeh, OBE, AMIEE, the move is one to a seat on the board of Sperry Gyroscope Company Ltd

◀ Also going up in the Sperry organisation is T C Howell, caught against one of the company's storage drums. Howell moves to General Sales Manager of the Industrial Division

Holding down a key job into which he moved recently is P A Charman. Youngster Charman is the Sales Development Manager of Semiconductors Ltd—the components firm jointly owned by Plessey and Philco (USA)

REPRINTED from **"THE TIMES"**

ADVANCES IN MECHANIZATION IN THE OFFICE

SPEEDING UP WORK ON ACCOUNTS

The recording and analysis of business statistics, or data processing, as it is more generally known nowadays, has come to be regarded as an exercise, presumably of value, carried out by firms large enough to afford electronic equipment or well staffed enough to be able to spare a sufficiently large force to perform the lengthy operations needed.

The halo of mystery surrounding the installation of high priced electronic computing machinery has tended to obscure the advances made in mechanical calculating equipment, as well as in electro-mechanical devices which are priced in thousands or even hundreds of pounds instead of the hundreds of thousands which may have to be paid for the latest types of computer.

For two or three thousand pounds the smaller firm can now equip its accounting department with machinery with which it will be able not only to keep its books efficiently but also to extract selected information for automatic analysis. This type of equipment, essentially standard accounting machinery linked to a paper tape or card punch, has been in use in the United States for two or three years.

STILL NEW

In Britain, however, it is still new, having been applied by a handful of commercial and industrial companies only during the past year. Accounting machines fitted with punches, wired machines as they are called, have generally been thought of in association with the preparation of input tapes for computers, but it now appears that for every installation feeding directly into a computer there will be dozens of machines producing tape for processing at computer centres, for "translation" into punched cards or simply for storing information in a compact form which is much cheaper than microfilm. There must be a limit to the number of companies in Britain which need, if they can afford, electronic computers (although the size and cost of newer models are being progressively reduced). The wired machine, therefore, is a decisive advance in clerical mechanization.

Key-board-operated machines are used in the normal way to produce working documents such as stock record cards, ledger cards, payslips and invoices. The operator ignores the fact that there is a punch attached to her machine. Meanwhile, selected information is automatically captured from the keyboard operation and punched either into paper tape or cards (the latter being less flexible, and requiring more bulky machinery). Such information can be picked up from the original keyboard entries or from the mechanical registers in the machine which provide totals. The extracted data transferred to the tape or cards can then be processed automatically to give statistical or financial reports.

INTEGRATED SYSTEM

Two kinds of information are thus produced on an integrated system which calls for no manual transcription or document sorting after the original entries have been made — the visible records and working documents for immediate use and the statistical analysis for audit or higher management reports. This method is superior to the conventional punched card system, where all the information is punched into individual cards at the beginning, because it simultaneously creates a readable and proved document.

It therefore eliminates the time consuming tasks of keypunching and putting the cards through a verifier to check that the punching has been accurate. The new unit machines will be strong competitors of punched card systems. There is the added advantage that where a central office needs regular data for analysis from its branches the paper tape information can be immediately and automatically transmitted by teleprinter or Telex systems. One large bank is considering such an installation which will allow the head office to analyse centrally the accounts of all the branch banks regularly and rapidly.

A manufacturing company has been using wired machines for some months as a stock control system. Receipts and issues of all raw materials and parts are posted on stock record cards on two Class 31 machines of The National Cash Register Company, who have devised their integrated data processing method. Simultaneously, the machines calculate the new balances, using a tear-off warning slip incorporated to show when stocks are nearing re-ordering levels.

COLLECTED ON TAPE

When a receipt has been posted the stock card passes to an operator who calculates the new average price so that future issues can be valued correctly during posting. When issues from stock are recorded, information is automatically collected on tape which identifies the material by serial number and gives its quantity, value and a cost code, showing the process for which the material is going to be used.

All these tapes can then automatically be converted to punched cards which can be filed until the end of the month, when they are sorted by identity number and cost code to provide the costing department with prompt and accurate figures. By this means the firm can control stocks in three widely separated factories in London, Liverpool and Glasgow. The stock department is able to supply valuations for the monthly accounts punctually on the fourth working day of the following month. In the past, such regular provision of figures has never been possible by manual operation, nor even with conventional mechanical means. They also obtain more accurate cost data with far less trouble than previously.

An engineering company also uses the unit machine system for stock control but has extended it to keep track of each batch of components as it moves through the stages of manufacture. The progress chaser's job is made easier, but at the same time work-in-progress evaluations can be periodically passed to the senior management by simply

transferring the day-to-day information to punched cards for analysis on an electronic calculator. The magnitude of this particular application may be grasped when it is learnt that the company's range of products demands the handling of about 30,000 different items.

DESIGN COMPLEXITIES

The separate mechanical elements in the wired machine system have been in use for some years. The simple step towards linking desk accounting machines, calculators, cash registers and even bus conductors' ticket issuing machines with tape punches presented many practical complexities, notably of design. With the larger machines, and with cash registers, these difficulties have been resolved. The National Cash Register Company have many such applications in hand.

Some trading companies developing more complicated data processing systems are looking beyond the use of punched paper tape, and experiments have been conducted with magnetic tape, and even with printed paper tape to be read by scanning devices like Solartron's E.R.A. (electronic reading automaton), but so far the wired machines lead the field in actual working installations.

In the United States, where the wired machine made its *début* about three years ago, several thousand installations now exist. The figures of machines actually sold, when set against the number of systems in operation, show that the single machine installation is the most popular. It may be deduced that the users include a fairly high proportion of small firms.

PATIENTS' ACCOUNTS

One such "firm" is in fact a physician who is using a book-keeping machine and tape punch to work out his patients' accounts. His receptionist posts the ledger cards on the machine, and the tapes she automatically punches are sent to a punched card service bureau which returns to the doctor a daily cash sheet analysis, itemized statements and any other data he requires for his accounts and for income tax returns.

Other American users include publishers, loan companies, stores, manufacturers of all kinds, hospitals, film distributors, electrical power companies and construction engineers. With British manufacturing companies, insurance houses, transport operators, banks and even a newspaper putting in these machines or preparing to do so, such equipment may eventually be almost as common a sight in offices as dictating machines are today.

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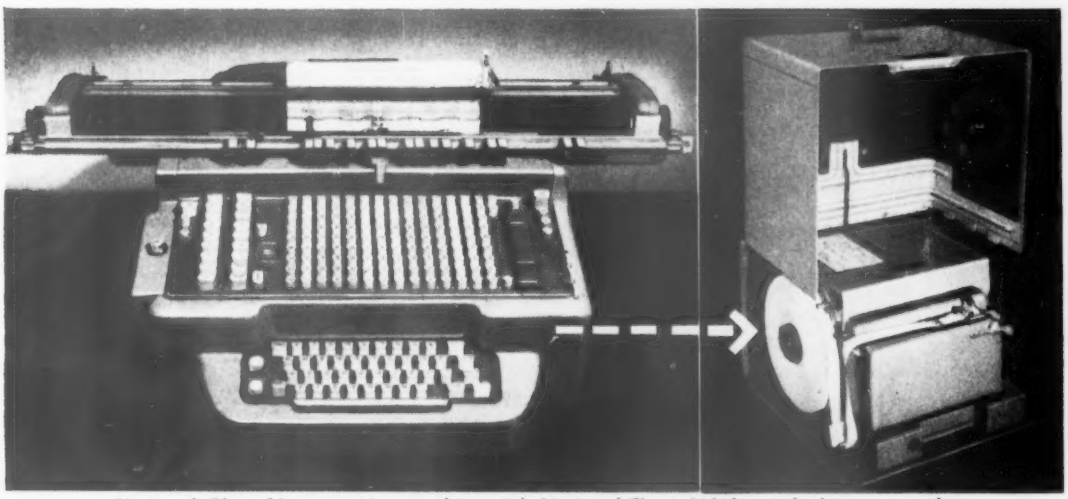
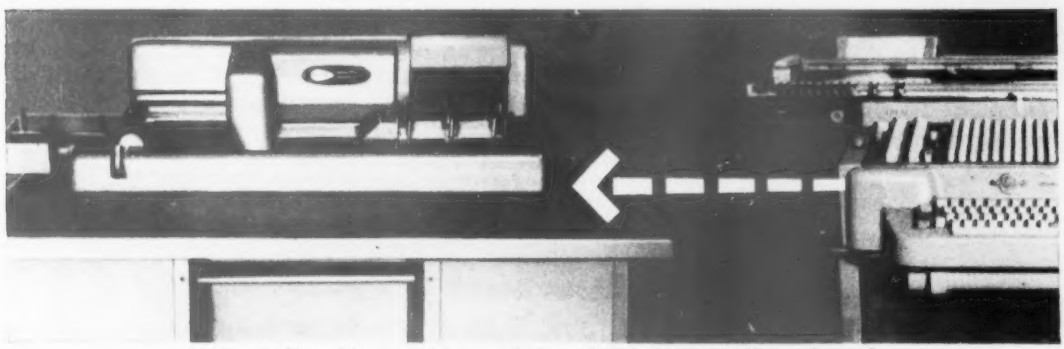


National Class 31 accounting machine with National Type 461/2 punched tape recorder



National Class 31 accounting machine with I.C.T. Type 029 card punch

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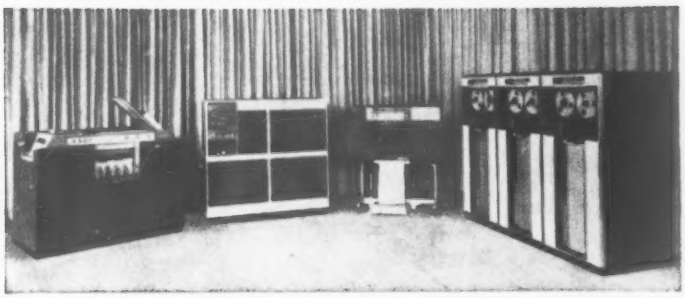
success story



Seven months ago we announced an entirely new small computer with very fast input and output—the IBM 1401 Data Processing System. We were certain that many commercial organisations needed a machine that would bridge the gap between the normal punched card system and the large-scale computer. And we were right. To date over 40 machines (about half of them with magnetic tape units) have been ordered in the United Kingdom. The first will be installed in 1961.

who is buying the IBM 1401 ?

Orders have been received from the following:—

- Bank of Scotland
- Cheshire County Council
- City of Plymouth
- C. & J. Clark Ltd.
- Coty (England) Limited
- Durham County Council
- Esso Petroleum Company Limited
- Gillette Industries Limited
- Alfred Herbert Limited
- Johnson & Johnson (Gt. Britain) Limited
- Lloyd's Policy Signing Office
- Manchester Regional Hospital Board
- Mars Limited
- Mercantile & General Reinsurance Company Limited
- The Mersey Docks & Harbour Board
- The Herbert Morris Group
- A. C. Nielsen Company Limited
- The Royal London Mutual Insurance Society Limited
- Shell International Petroleum Company Limited
- Wesleyan and General Assurance Society
- United Kingdom Atomic Energy Authority

et al.

* *With magnetic tape units*

what jobs will they do?

Here are some of the jobs these IBM 1401 machines will be doing:

Payroll
Stock control
Sales ledger and statements
Invoicing
Statistics
Credit accounting
Production planning
Costing
Insurance—premium accounting and policy recording
Hire purchase accounting
Banking—current accounts
Nuclear research

The IBM 1401 Data Processing System in brief The basic 1401 system consists of just three units which offer

- **card reading at up to 800 cards a minute**
- **card punching at up to 250 cards a minute**
- **line printing at up to 600 lines a minute**
- **advanced stored-program calculating and control.**

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What is Automatic

A short-cut method for producing computer programs: you write what you want the computer to do in simple code (it could be in English words) and the computer does the rest

J W Mitchell

MUCH is written nowadays about automatic programming, compilers, common languages, assembly routines, etc. To the layman, interested in data processing, this can prove confusing, especially as in the course of his reading he may find that 'The Council' of a certain professional body 'has set up a sub-sub-committee to investigate the possibility of a "common language" for data processing,' or that 'An international body have introduced a "common language" glossary,' or again that 'A manufacturer produces a complete range of "common language" machinery.'

His confusion is augmented when he learns that all three statements on 'common language' refer to different subjects.

So the term 'common language' requires some explanation of the meanings it has acquired. It can be used in three ways:

1. A dictionary, or glossary, of technical terminology to be used by a body of people, possibly internationally. In this case, we instance the adoption by the British computer trade of the American spelling of 'program' for a machine series of instructions. (Ironically, American companies operating in Britain appear to use the English spelling.)

2. A standard coded format on a medium for transferring information which can be interpreted for different purposes by a number of machines. Punched cards and punched paper tape are common examples of the media employed to transfer information in a variety of common languages from one machine to another.

Coding?

3. A system of coding for information, whereby the information is automatically translated into the correct internal code of any available computer. It also implies that any computer code can be translated into the coding of the common system.

The last definition is the sense in which 'common language' will be understood in this article.

It is noticeable that 'common language' research has developed along two distinct lines.

Firstly, obeying the strict interpretation of the definition given, bodies of people are working hard at producing a 'common language' or computer code. This will, in effect, be one more 'language' for programmers and coders to learn. In conjunction with it are to be developed *translation routines*, enabling any program in the common code to be re-coded in the language of any computer, or vice versa.

The logical outcome of such a common language should be for computer manufacturers to agree on a standard digital representation for their binary coded characters, and to adopt the common language for programming purposes, so that no translation routines would be required.

Computer programming could then be taught in technical schools, persons passing the end-of-course examination being awarded a diploma, qualifying them for work on any computer installation without the necessity of learning a new language. Programs could be written for and tried out on any computer, and the decision as to which machine to purchase, dependent upon such matters as purchase price, operating speed, storage facilities, etc, left in abeyance. Finally, data on magnetic tape, etc could be fully transferable between any two machines.

This Utopian ideal is, it must be admitted, extremely impracticable. Different machines are designed obviously for different purposes. This not only means different operating characteristics but, also, varying principles of operation. The differences require not just alternative alpha-numeric representation of the functions and addresses, but variations in the numbers of addresses as well—from one to three on different systems and, possibly, an extra address if the program steps are stored for maximum access speed rather than in strictly sequential order.

No manufacturer has, as yet, attempted to build his own complete range of equipment using the same internal language. However, most companies have endeavoured to arrange for the peripheral equipment of all their systems to utilise common languages (of the second category defined earlier).

In the case of most computers on the market,

differences will be found in the internal languages of the various 'models.' Naturally, after a computer is introduced, refinements are reflected upon by the designers and engineers, and are introduced on the later models of the same machine. It is customary to defer introducing these alterations for a year or two, until many amendments have been accumulated, but this is not always done. One well-known computer has had the modifications effected on the production line. As a result, nearly every different machine has slight variations in programming from all the others in the range. This means that programmers and coders would, but for the existence of compilers, have to be trained for an individual machine and not for the model, as is usual.

Let us look at the second line along which the search for a common language has developed. Here, the thought has been that what is required is not necessarily a completely universal language, whereby machines can 'speak' to one another but, rather, a language which can be quickly learned by programmers and which can be converted by any computer into its own machine coding. The

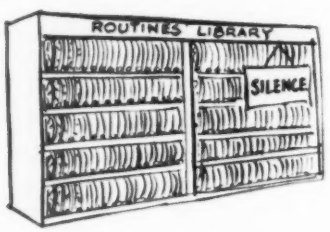
programs for effecting this conversion are known as ' compilers.' It is in this direction that the greatest strides have been made: compilers are being made available by most manufacturers for their machines. Additional compilers have also been developed by users programming staffs.

The term ' automatic programming,' (which self-evidently does not exist) is generally used to cover various facets of these systems: it should, it is felt, be dropped in favour of the more correct appellation ' automatic coding.' In using these systems, an analyst has still to ascertain what work needs to be done, what information is available, and what results are required, and a programmer has to work out the sequence of processes which the computer will have to follow for completion of the work. The only work which has been obviated is the drudgery of converting the program into machine code, a task the coder used to perform (though not in every case).

BACKGROUND TO COMPILERS

As computers came into use, routines were gradually built up. It did not take long for scientists to realise that a cube root routine, for instance, did not have to be programmed and recoded for every program requiring its use. Eventually, large numbers of standardised routines were developed by manufacturers and users, and were held as a library, available for use at each computer centre. Originally, routines were held on punched cards, or tape, and, when the computer program was constructed, cards had only to be punched for the non-standard sections of the program, the standard routine being used, wherever possible.

After a time it came about that routine libraries were held on magnetic tape and, when a program was being built, the various routines had only to be read off one tape, as required, and fed on to another tape, in correct sequence. In using these routines, however, it was necessary to correct, by hand, their addresses—the relative addresses within each routine being changed to the correct addresses for the over-all program. This was even more important in cases where iterative loops covering several routines had to be taken into consideration.

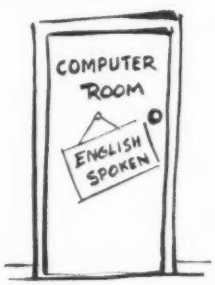


The next step was, obviously, the introduction of a ' compiling ' program which, with the addition of the library of routines and an input of the routines required, would extract the correct sequences and rationalise the addresses. This system was soon adopted by the commercial users who, in conjunction with the manufacturers, often arranged to exchange routines one with another, the provision of commercial routine libraries being thereby brought about.

Although these methods of compilation were commendable, there were, nevertheless, many anomalies, and a certain amount of new coding remained to be done. Even after the provision of input and output routines, a certain amount of re-marshalling of programs was necessary—a compulsory activity if the best results from programs, compiled from library routines, were to be ensured; hand-coding parts of the program for which routines were not available was also entailed.

In order to overcome the inherent drawbacks of library compilations, scientific workers quickly developed direct compilers which, given the formulæ in coded input form, could build up programs and arrive at the solutions. To achieve this goal, it was arranged that certain symbols be recognised and incorporated in setting up an appropriate mathematical routine on the variable data sent in. Such programming compilers as FORTRAN and MATHMATIC are now in everyday use.

It was soon found that the convenient symbol formulæ, readily intelligible to scientists, were unsuitable for commercial usage. At this time, computer manufacturers decided to investigate the possibility of introducing a commercial compiler which would build up coding from a standard, readily understood, input.



Whilst the manufacturers were pondering this problem, the American Air Force came forward with their solution—the common language of everyday use, English. The result was AIMACO, the U S A F Air Material Command Compiler. This compiler was developed by them in conjunction with Remington, and was intended for translating, into machine code, English language instructions. It has been successfully used to program such varied computers as the Remington Rand Univac 2 and Univac 1105, the IBM 650 and 7070, and the Burroughs 220.

From this beginning, the Remington Rand Flow-matic Compiler was developed. Similar compilers are available from most other manufacturers for their systems, the most noteworthy being IBM and, lately, Ferranti, and Computer Developments Ltd have also entered the field.

Before examining the principles governing their operation, it is useful to state some of the advantages of compilers:

1. By organising and flow-charting computer runs, a basic program is provided, thereby obviating the necessity for coding. Instead, a statement in English of what the program is intended to accomplish is made, skilled interpretation of symbols being dispensed with, and a considerable amount of time is saved.
2. Whereas only a trained programmer or coder can check and 'de-bug' a machine-language program, any English-speaking person can check and de-bug a compiler input.
3. If there are any errors, misdescriptions, etc, sent in, the compilers will be unable to code that part of the program, and will reject it. At the same time, the compiler will inform the operator or programmer of the exact point at which the error occurs. As a result, when de-bugging and investigating errors, the programmer does not have to waste valuable time searching the program for the point of error.
4. Management are able to check rapidly all new programs, and to know immediately what is happening. Management can also learn quickly how to prepare their own programs, gain complete control over the data processing, and no longer become dependent on the programmers.
5. Alterations, amendments and additions can quickly be introduced. An amendment can be written in English, and be inserted into the original write-up, which can be fed through the compiler again in far less time than would otherwise be required if re-coding were necessary.

PUTTING COMPILERS TO WORK

With scientific compilations, the variable factors form part of the input for the problem to be solved, and, immediately it has been coded, a program can be run through the computer. In commercial use, however, a program needs to be sufficiently versatile to contend with continually changing data; in consequence, business compilers must be more complex.

Basically the use of a computer for scientific purposes entails the feeding-in of the problem and obtaining of results; the commercial use of computers, by contrast, necessitates far more complex routines. One or more sets of data are fed into a system (usually, a master file and change file at least) and, according to the nature of the data, different problems are resolved and one or more sets of data are fed out (usually, an up-dated master file, a query file of unprocessed items, and by-products, such as analyses, etc).

The most obvious difference is that, for commercial routines (as opposed to scientific work), the input and output are separate from the problem, yet a standard format, enabling processing to take place, can usually be established.

The first requirement for a commercial routine is, therefore, the establishment of the input and output format. These two are best dealt with together, the design being similar and the output format of a file for one program being often, in fact, the input file for the next. This information is required by the compiler, in order to allocate the necessary internal storage. It is also necessary for it to know which input and output units are involved, so that, when generating the input and output routines in the main program, the internal transfer of information to and from storage is reduced to a minimum.

The following basic types of information are required for all input and output items, master files being applicable to both:

Name of File
Size of Item
Input Unit
Output Unit
Number of Fields in Item
Name of First Field
Size of First Field
Name of Next Field
Size of Next Field
Etc
End of Item.

After all the input and output items have been conveyed to the compiler, a few special symbols remain to be specified which, for recognition purposes, should be built into the program, as, for instance:

End of Tape Sentinel
End of File Sentinel.

Several files may be held on one tape, or alternatively, one file can be spread over several tapes. Readily recognisable, but unique, sentinels should be employed, as, for example, a field of percentage signs, common to all programs on the system.

A certain amount of working storage would be necessary in the program. Although sections of the input and output storage can often be designated for this purpose, it is, nevertheless, frequently necessary to provide extra space. When this is required, a working storage description should be fed into the compiler to allocate the necessary storage. Wherever possible, the fields of working storage should be named, but, if classification is not possible or the same field has to be used for several different purposes at different points in the program, it may be more convenient to refer to the routine as 'working storage No 1,' etc.

The compiler now knows the amount of storage which is left for the program, and the names of all the fields to be referred to in the program. It should be possible, therefore, to write a program in English, using only the given field names and instructions which the compiler can understand. If any words are used in the program which do not come into these categories, the compiler will query them.

The next section of the input consists of the program steps. Generally, these take a similar format for most compilers, as follows:

1. A serial number, which acts as an identification for that portion of the program concerned. When portions involving conditional, or unconditional, jumps are being written, the serial number of the program step jumped to can be quoted in the write-up.
2. The function description, informing the compiler of the steps to be programmed, in English.
3. The description of the items to be operated on made according to the input/output format.

Some typical steps are shown below, the item descriptions in italics:

29. Compare *employee number* to *payroll number*.
    If equal, continue
    If less, jump to 41.
    If greater, jump to 49.
30. Add *bonus* to *basic pay* equals *gross pay*.
31. Subtract *tax free pay* from *gross pay* equals *taxable pay*.
32. Ignore.
    etc.

The 'ignore' instruction is useful, as, if it is decided later to alter the program, a different series of instructions can be inserted in place of the 'ignore' instruction, thus enabling alterations to be effected rapidly.

In addition, most compilers have special instructions which make provision for the insertion of manual coding, or extracts from a program library. These instructions make allowance for correcting relative coding to actual addressing.

The compiler itself is not a single program, which from a given input provides a complete coding of the problem. It is, in essence, a series of programs achieving this end. Thus it is

- *a translation routine*, reading in the English language and re-recording in a suitable format for processing;
- *a selector routine*, to read in the functions required from the program library of basic functions for the coding system, and to generate a sequential library of functions for a particular problem;
- *an allocator routine*, to allocate the computer memory to the input/output data and to every step of the program; and a
- *processing routine*, to take the generated functions library and the memory allocation, and to build up the program with correct and relative or actual addressing, according to the computer system.

At the same time, various printed outputs are usually provided as a record of the program for editing purposes, etc. Often, further routines, such as an analysis routine, are used for checking that the complete program will run. There are no endless loops or optimisation routines, to re-allocate the memory in a more beneficial way with regard to computer timing, etc.

The actual runs to be employed for the compilations vary, according to the auto-coding system employed and the actual computer for which the program is to be written. In addition, many special programs are written for most computers, such as analysing and de-bugging routines for programs. These accomplish much in easing the burden of work for the programmers and coders.

ADVANTAGES

Although the development of automatic coding techniques is, as yet, still in its infancy, it is evident from the progress which has been achieved to date, that the task of programming will be greatly facilitated.

The new techniques are readily comprehended within one or two days, as opposed to the several weeks normally required to teach programming to neophytes. Programming for normal routines will take mere weeks, instead of the years formerly entailed. The cost of computer time will be far less than that of the coding which it replaces.

Management will easily and rapidly be able to check programs, and, as mentioned earlier, will be able to dispense with a specialist programming department. In fact, the outlook for commercial users, employing these techniques, is extremely bright.

Hand-coding will not, however, be completely eliminated, as the first compilers have, at present, to be prepared in this way. It has been known for a compiler to write an improved compiler for a computer from an English language write-up of the work required. This leaves plenty of scope for thought on future developments possible in this field.

The Anonymous Face of the Investigator

Suddenly a 'systems study' is announced and a team of strangers descends on the offices and begins to question what is done. People countenance better the anonymous investigator if they are told what he is about

T L Craven

THE setting is the main Liverpool works of Automatic Telephone and Electric Co Ltd, well-known manufacturers of many varieties of telecommunications equipment including automatic telephone exchanges and long-distance transmission links.

In the middle of 1958 the company established a team of six to carry out a study of its clerical procedures with the aim of achieving, possibly (though by no means necessarily) through the greater use of automated data processing methods, improved facilities for control by management at all levels. The study has just been completed, and its findings are currently under discussion. This, then is the moment to look back to the beginnings of the study.

Recruited internally, the members of the study group were selected because, amongst other things, they each had considerable experience of the work of at least one department, and usually some appreciation of the work of others as well. However, unavoidably in a company employing about 10,000 people, there were large numbers of faces and activities, even of places, unknown to any one member of the group. To form a clear and co-ordinated mental picture of the company's activities in their entirety was therefore difficult. Despite good initial publicity and backing from the management, the six, when they began investigating, felt a little uneasy as to the reception they would encounter, in an arena peopled by anonymous faces.

SOMETHING TO SHOW

The start of the investigation was difficult because there was nothing for the interviewers to

Flow charts were used to show to those interested or concerned just what the team were up to

show, and little for them to say beyond an expression of intentions and aspirations, in explanation of what was afoot. However, enough information was soon collected to permit the preparation of the first flow charts. This meant that people could be invited to visit the study group's centre of operations where, by perusing these charts, they could gain an understanding of the sort of information being collected.

The type of flow chart that was used evolved gradually in the first few weeks. No attempt at standardisation was attempted, for it was recognised that, as a record of a changing situation, the flow chart was a temporary document. Nevertheless, close contact between the members of the team meant that their several methods of recording were closely similar and understood by all of them: in fact, the method used was a combination of narrative and symbols, and as such was self-explanatory.

So, with flow charts to show what was being done, and with an increasing awareness throughout the company of their activities, and a greater sureness of the sort and amount of detail that they wanted, the team gained confidence, and a set pattern for their work emerged.

MAY WE INVESTIGATE?

Before starting investigations the head of each department was first approached by the leader of the team for his formal permission. This was in all cases readily given, and frequently the department head would help by giving an outline of the structure of his department, and suggestions as to the best order in which it should be studied. Failing that, there was usually at least one senior member already known personally to the interviewer, and he would pave the way in a similar manner, and effect an introduction to the first man to be interviewed. The first man could then be relied upon to introduce his colleagues, and if necessary to explain further the structure of the department, so in a short time an interviewer obtained a general picture of the ground to be covered, and could assess how best to go about it.

Before anyone was interviewed, he was welcomed to the study group's premises so that he could see exactly what the group was doing before he, in turn, was asked to talk about his own function.

It was made clear to him that it was the whole organisation that was being studied, and not just his own department. The existing flow charts were invoked to lend point to an assurance that the study group had no intention of under-estimating the complexity of people's jobs or of producing within a short time a host of ill-considered suggestions for improvements. For the flow charts showed that every routine that could be traced was being recorded in detail, without at

this stage any consideration of its relevancy to the main purpose, and it was emphasised that this was because the study group was only too conscious of the bystander's ignorance of the finer points, and the need to take the trouble to find out exactly what each man did and what were his problems before hazarding proposals for changes.

INTERVIEWING PEOPLE

Except in that they were always concerned with the flow of documents (and the action these generated) there was no set drill for the interviews, which took the form of informal unhurried conversations. The starting point was quite often chosen at random, and the different threads that it led to were pursued until no more aspects would come to mind.

The interviewer always pointed out that the team wanted to find out not those things which were supposed to be done, but those which were in fact done. Also it was emphasised that the team was concerned not with uncovering or criticising people's shortcomings; it was the system that was being studied, and the problems that people had to contend with as the result of the system's shortcomings.

As soon as a flow chart for a particular job or department had been completed, it was agreed with those who had contributed the information and with the departmental head. It was then displayed on the wall of the study group's headquarters. This made for ease of reference: as anyone in the company was always welcome to visit the premises, it meant that the information obtained to date was immediately accessible to anyone who wished to use or study it.

The team found that the accuracy and completeness of the information obtained in the investigations was of a high order provided that the work was done with care. In this respect, to avoid misunderstandings, the interviewers took nothing for granted and asked to see for themselves everything they were told about. For example, they ensured that the copies which they collected of the documents encountered were filled in exactly as in current practice. They had to be constantly on the look-out for passing references to procedures they might not yet have encountered, and they talked to juniors, whose different point of view frequently brought to light routines unknown to those carrying more responsibility.

Useful cross checks sprang from the fact that most routines involved at least two people—the sender of information and the recipient of it—so that if something was overlooked or misunderstood in an interview its complement was certainly encountered in due course, and the ultimate building up of a complete picture then revealed a discrepancy in the flow chart.

THE THINGS THEY SAID

People's reactions to the investigation were almost invariably favourable—far more than was ever expected at the outset. In fact, the interviewers soon found they were welcomed in any department they approached. Not only were people extremely ready to talk about the details of their jobs, but they would go to great lengths to try to ensure they had left nothing out.

For this there were probably three causes. An investigation of any sort naturally arouses great curiosity. People knew that when their turn came for interview they would also have the opportunity of hearing precisely what was afoot.

Secondly, there was general approval of the team's policy of taking nothing for granted, and of recording everything in detail without any consideration of its apparent significance or relevance to the main theme: it soon became clear to the team that there was no danger of a painstaking search arousing resentment — which a more superficial approach might have produced.

Lastly, there was an eagerness to see a co-ordinated picture of the company's activities, and many people hoped that this would lead to a clarification of the purposes of their jobs, and to a greater adequacy and accuracy of the data on which they were to base their decisions.

Inevitably there have been sceptics of the venture. Yet, few have disagreed that an attempt to portray the procedures of a large and complex organisation as a unified picture that everyone can grasp, and to probe the validity of the assumptions built up over the years, is a worthwhile speculative effort. The next step is to devise improvements. Certainly the planning of new procedures and—the most difficult stage of all—their implementation, will be enormously helped by the good will established in the course of the investigation.

THE AUTHOR

T. L. Craven, by training an engineer with considerable experience of the telecommunications industry, was a member of a systems study group which recently carried out investigations at Automatic Telephone and Electric Co Ltd

Only Profits Justify the Investment

The costs of an ADP installation have to be considered as investments and no rational business ever invests just to break even

T S Bayley *Urwick Diebold Ltd*

ANY company adopting automatic data processing will be involved in a major investment in equipment, in time and in effort. The decision to make this investment will be based on the same considerations as the great majority of investment decisions. Costs and profits must play a major rôle. The calculation of these is, therefore, still the crucial point in any automatic data processing project, and it is towards finding what the costs and benefits will be, and how and when they will be realised, that the initial studies are directed.

The cost calculations that arise in an automatic data processing project are complex, far more complex than those that lie behind most investment decisions: often these are performed only roughly and many factors may be ignored completely. Even when the basic issue itself is abundantly clear, as it may well be in an ADP project, it may for many reasons be extremely difficult, if not impossible, to make clear-cut, accurate estimates.

In the first place, the new or automatic system is often so different from the existing one that it is hard to make realistic comparisons between the two.

Secondly, since the equipment will not be installed for about two years after the decision to proceed has been taken, future as well as present conditions must be considered in making the cost calculations.

Finally, a material part of the benefits from an integrated data processing system are often hard to estimate in advance and equally hard to evaluate once they have occurred. For instance, it would be extremely hard to measure the value of being able to operate with 100 less clerks when clerical staff are hard to recruit or replace; again,

it would be impossible to state the worth of having under one roof two or more allied departments which, but for reduction in clerical staff, would have to be separately housed.

Despite these difficulties, decisions on automatic data processing have to be made, and wherever possible they should not be made as 'acts of faith'. The following paragraphs present some observations that are intended to be of assistance in making a cost calculation that can form the basis of a sound decision on the introduction of automatic data processing. Needless to say, no valid cost calculation can be made without first conducting a proper feasibility study which establishes a clear idea of the benefits to be expected from automatic data processing, the full costs of operating such a system and the cost of the present data processing operations.

PRESENT COSTS

Even here it is necessary to resort to estimates. The feasibility study must start by establishing as precisely as possible the actual costs of performing current data processing activities with present methods. These costs should be adjusted to reflect the savings that could be made by improvements within the framework of existing methods. In practice, adjustments are generally made only in cases where the possibility of major improvements has come to light, otherwise the figure becomes too hypothetical.

The next factor by which present costs must be adjusted is the increase or decrease due to the estimated growth or decline of activity, especially as applied to data processing. This figure is hard to arrive at, for it involves not only a prediction of future business activity, but also the determination of the effect of such growth on data processing costs. In practical terms the most realistic results will be obtained by interpreting future changes in volume and items handled in terms of changes in documents, both as regards the number of their content. The probable increase or decrease in clerical wage rates must also be taken into account. Inevitably the adjustment factor will be determined largely by some sort of estimate, but provided this is applied in the context of its likely accuracy, the result should not be too wide of the mark and will be infinitely better than no estimate at all.

There is a very good reason why such estimates of the future position should be made. One of the effects of an automatic data processing system is to convert many variable costs into fixed costs. This applies to upward as well as downward movements. For instance, unless the automatic system becomes fully loaded, its cost will increase very much less as the result of, say, a 50 percent increase in work load than would the cost of a manual system. Conversely, its cost would decline significantly less in the face of a 50 percent reduction in volume. An automatic data processing system normally becomes operational about two years after the decision to proceed has been made and must function economically for about five years thereafter, hence a decision must be made at least as much, if not more, on the basis of future conditions than on the present.

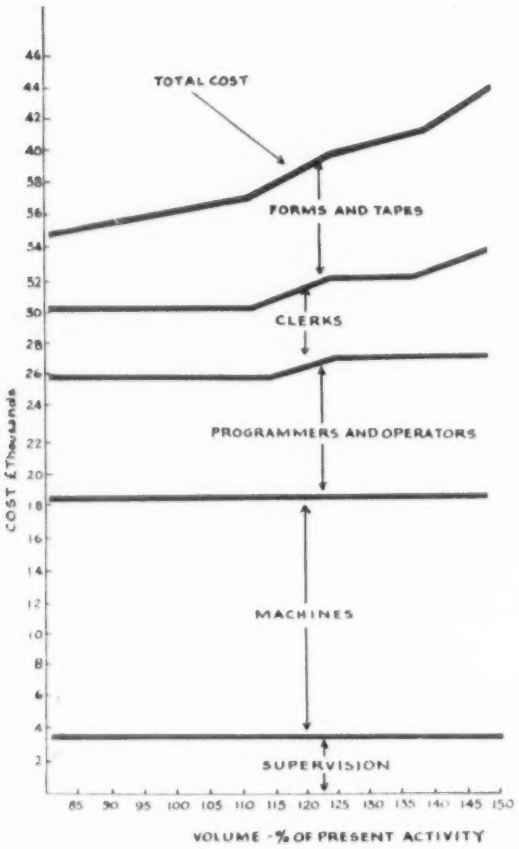
One of the most striking illustrations of this was the case of a railway company in the United States that ordered a passenger reservation system with approximately 200 input stations. During the two years that elapsed between placing the order and installing the equipment, passenger traffic fell to such an extent that less than 75 input stations were required at the time of delivery. The opposite may also happen, that a system which can barely be justified financially on present volumes may well prove profitable on the basis of the volume of activity anticipated two years hence.

The requirement of such predictions is one of many factors pointing to the need for top management to turn its attention to automatic data processing, since they are the people who should have a better idea than anyone of the future course of the business.

COSTS OF THE NEW SYSTEM

The costs of the present system must obviously be compared with those of the proposed system. This means that the total costs of the proposed system must be established, including the continued cost of performing manually those operations which will not be brought within the orbit of the automatic system. It is much better to make

Estimate of Cost under Proposed System Various Volume Levels



the comparison on this basis than to try to isolate the present costs of those operations which will be absorbed into the automatic system.

The latter method often ignores the extra load that may be put on some sections of the organisation so that the most effective use is made of the automatic system. For instance, the transfer of order processing and billing to an automatic data processing system may save a considerable number of staff in those sections where it is done at present, but it may call for additional sorting, checking and scrutinising of the appropriate documents when they are first received. A public utility which recently installed an automatic data processing system had to make provision for a 20 percent increase in incoming telephone calls, a cost that would not have been taken into account had the cost of the new system been compared with the old in terms of specific applications rather than total costs.

The future costs of the proposed system should be estimated, either on the basis of varying levels of activity or, if the levels of activity for the next few years can be forecast, on a time basis. A typical graph of costs is shown on this page.

In the case of comprehensive automatic data processing systems, purchased equipment will usually bring about a fairly straight horizontal line with costs increasing for such items as forms, cards, power, and to some extent personnel. Even with purchased equipment there may be sharp steps and additional shifts are added. In the case of rented equipment the corresponding steps will be much larger.

In calculating the cost of the proposed system, it is obviously important to incorporate all the costs that are encountered, including power, punched cards, tape and personnel engaged on keeping programs updated. It should not be forgotten that even where conventional data processing methods are employed, it is advisable to have a systems team employed on continual improvement of the system. To the extent that such a team has not existed before but would continue to exist even if the proposal to employ an automatic data processing system were rejected, the cost of the team should be included in the calculation of present costs.

PLOTTING THE BREAKEVEN POINT

An effective way of illustrating the relative costs of manual and automatic data processing methods is to prepare a graph similar to that on page 23 on which are plotted the costs of data processing by the two methods at varying levels of activity. This will serve to show the breakeven point, and while it has been stressed that great attention should be paid to future costs arising from any anticipated increase in activity, the chart may show that the breakeven point has already been reached.

However, if this point has not been reached and if the probability of achieving certain levels of activity at certain times is sufficiently high, it is a simple matter to plot costs, again under both systems, against time and thus indicate at what point in time an automatic data processing system would be justified on financial grounds.

This approach, unmodified, works well for systems that are concerned primarily with clerical procedures, or for concerns whose main data processing activity is document handling public utilities, brokerage, insurance, etc.

For other companies and systems, the comparison is likely to be made between systems that produce *dissimilar* results. In a recent case, for

example, a computer system provided for an inventory control and for production planning that had not previously existed. The automatic system was adopted although it cost some 5 percent more than the original system and no significant expansion of the company's activities was anticipated. Evaluation of such additional benefits in these circumstances becomes a problem which is often ignored. There will be times when the system can pay for itself completely without taking into account these additional benefits, and it may therefore seem unnecessary to spend time and money in arriving at an estimate of their worth. On the contrary, their evaluation serves two purposes. Firstly, it demonstrates the best case that can be made for installing ADP and, secondly, it causes the study team to look more searchingly for advantages which an ADP system can give. In this way it overcomes the danger of exploiting only a part of the system's potential.

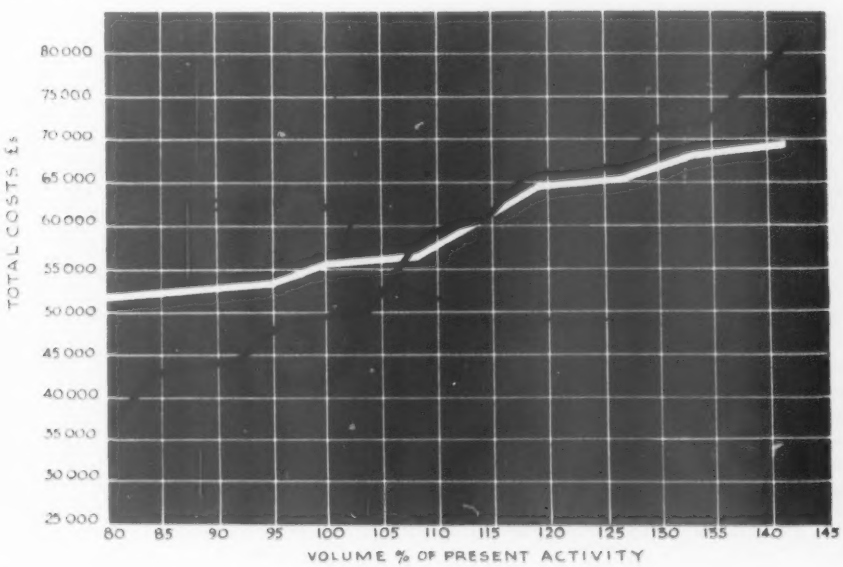
In other cases, failure to take these additional benefits into account can mean that a company which could justifiably employ an automatic data processing system decided against it because top management had not been presented with the full facts. The less telling advantages of speed, accuracy, automatic selection of significant or exceptional information, and the unforeseen benefits that users of automatic data processing systems have experienced, are sacrificed because the study team has omitted, intentionally or otherwise, to put a value on the information that was not available under the old system.

In every case, a valuation of the indirect results of having an automatic data processing system should be made. There are three ways of doing this and more often than not *all three* must be employed.

In some situations it is possible to arrive at a measure of value that can be expected from the results and this should obviously be done where possible. A typical example of this is inventory. It is frequently possible, in the light of experience and knowledge of the business, to calculate the amount by which inventory could be reduced if better information were available. It is possible to calculate the cost of carrying a given amount of inventory having regard to space occupied, interest on capital, handling costs, deterioration and obsolescence. In addition to the cost of carrying excessive quantities, a value should be put on the estimated reduction in shortages which may well be quite significant, giving rise to overtime, unproductive space for temporary storage on the factory floor and even lost orders.

A second approach is to calculate how much it would cost to achieve the same results with the present system. Such comparisons are frequently unrealistic because it may be quite impossible to obtain the results without a computer. But to

Comparison of Present and Proposed Systems at Various Volumes



the extent that existing methods could produce them, the extra costs that would be involved can be estimated and added to those of the present system.

Finally, and this is the least precise of the three methods, ranges of worth can be established by the department in the company that is most directly affected. The sales department cannot say how much it is worth to be able to process a customer's order in 24 hours instead of 48, or to reduce delivery time by two weeks, but they can generally establish a range of values from which an estimate of the additional value can be used for purposes of comparison.

Only when all benefits have been valued can a fair comparison be made between the present system and that which is proposed. If no attempt is made to put a value on benefits the tendency is for management to sanction the computer on the basis of indirect and intangible benefits and then to look to the data processing department for concrete savings once the system has been installed and the initial enthusiasm has waned. At this point it would be most difficult to cite the intangible benefits originally claimed as a counter to a demand for concrete savings. In addition, the process subjects the intangible benefits to critical evaluation, a review that often does much to expose the fallacy of some time-worn assumptions. To cite an example, one company installed a medium scale tape system for the 'advantages' to be gained in lower stocks resulting from a centralised inventory control, only to realise on investigation by a new general manager two years later that inventory control was completely in the hands of the branches and even central inventory information available immediately and in utmost detail would not reduce stocks in the least.

ADP IS AN INVESTMENT

One does not generally invest money to break even. Nor does one invest money to obtain a yield which is too low to be acceptable. An automatic data processing project involves two types of investment. The first is in equipment, if the data processing machinery is bought. The second is in personnel and time, something that can be directly translated into money. In addition, there are the other investments in site preparation, tape libraries, punched cards, and forms. These costs should be carefully estimated but the cost of a feasibility study itself should not be included in such calculations because it is a cost that has already been incurred whether or not a positive decision is made. If the equipment is purchased, its purchase price can be considered part of the investment, an approach that has certain advantages over considering its amortisation or depreciation as part of the operating costs. The main advantage is that there is less tendency to write off the one-time costs as they occur and hence lose sight of the fact that they are part of the cost of the project. If this were done, a false picture would be presented to management. A further reason for adopting this approach is the fluctuation of both costs and savings from year to year. The cost of the project approaches nearer to that of a new production line than a normal replacement of office equipment, and in these circumstances it is natural that the decision to proceed should depend on the answer to the question: 'How long will it take before the costs have been recovered?' If the time is unreasonably long, the decision will almost certainly be negative.

Once the anticipated annual savings as well as the total investment required to achieve the savings have been determined, it is possible to divide savings into investment to arrive at the number of years required to recover the investment. Such a procedure, or more complicated calculations of the return on the investment are applicable if the annual savings are fairly uniform and do not vary significantly from the first to the last year.

Where annual savings do change, either because of an increase in volume of activity over the years or because of the adding of applications over time, a more detailed approach is advisable.

In this situation a table should be prepared showing year by year the savings or losses which will be deducted from or added to the investment value. Where this is done, the table should start before the installation of the computer when costs of systems design, training, and so forth are first incurred. In the initial stages there will inevitably be an increase in the cumulative amount invested but as the system goes into operation it should decrease until the investment is reduced to nil, or to put it another way, the savings have equalled the total outlay. On this basis it is possible to assess the number of years required to recoup the investment or the amount of profit that will have been made in a given number of years.

Either procedure provides a basis for making a decision. Similar criteria can be applied to this investment as those which are applied to other company investments. For instance, it may be the policy of a company not to invest unless the total anticipated gross yield over the next seven years represents an average of 25 percent per annum. In other cases, an affirmative decision may be made even though normal investment requirements are not met; but at least it will be a decision made in the light of future probability rather than one based on a feeling or hunch which may bring disappointment and heartsearching in the future.

The Automatic Warehouse

Orders are read off punched cards or paper tape

Goods are held in slanting shelves.

A NEW company—Solartron-John Brown Automation Ltd—was launched recently. As its name betrays John Brown and Co Ltd and the Solartron Electronic Group Ltd are the parents of the new company which has acquired the sole manufacturing rights for manufacturing and installing an automatic warehouse system invented by an American, Mr Donald Gumpertz.

The Gumpertz system is a controlled mechanical handling system for getting at goods stored in a warehouse automatically and without any manual handling. Instead of the conventional bins and shelving of present warehouses, the automatic warehouse is fitted out with rows of steeply slanted shelves, one behind the other in rows. Each shelf carries a single 'line' or product. A barrier at the lower end of each shelf prevents products sliding out of the shutes, and, when electro-mechanically actuated, allows one or more (as required) packages to drop onto a moving conveyor belt. A number of conveyor belts feed a main belt which delivers to one end of the warehouse.

An electronic system is used to draw goods from the shelves (*ie*. operate the barriers). An order for goods, prepared on paper tape or punched cards or in the form of printed figures which can be read electronically, would be fed into the system and would be recorded in computer language on a magnetic drum. Once a complete order was recorded on the drum the system would read it off and use the information to actuate the barriers at the end of each shelf in sequential order, starting with those shelves farthest away from the delivery point. So all the goods of one order would arrive grouped together on the main conveyor.

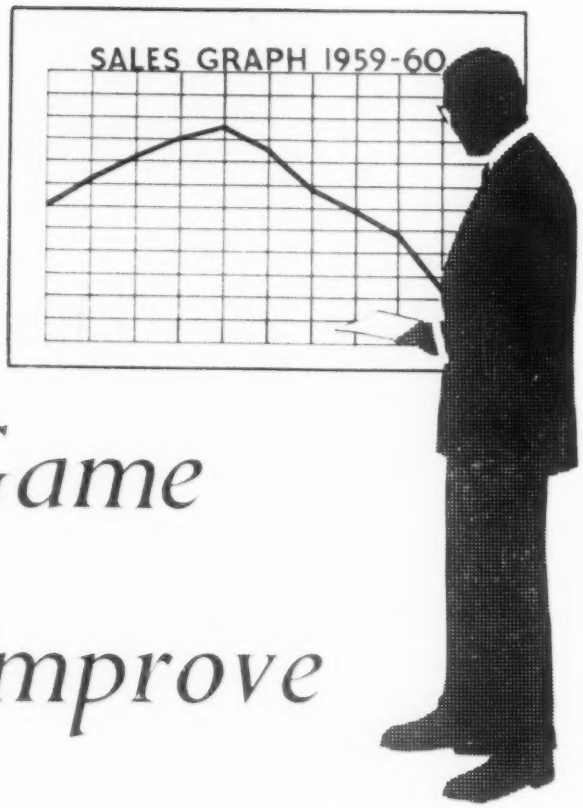
The system runs at such a speed that orders for five, 10, 50, 100 or more orders take 15 seconds to arrive at the delivery area after the order has been fed into the system.

Orders are automatically checked; shortages are signalled when a line is out of stock, so that advice notes can be amended.

If necessary a system can be built to provide the amended data required for automatic invoicing or advice note printing. The advice notes and addressed labels are placed with the goods for packing, etc.

As the automatic warehouse systems that Solartron-John Brown will build will be tailored to individual requirements, costs will vary. However, the company estimate that the cost of an average installation should be recovered in four years. Economic justification will normally start where a company handles an average of 1,000 orders a day.

The new company have obtained the rights for the Gumpertz system for every country in the world save the USA. In the USA one Gumpertz warehouse has been running for two years. The Brunswig Drug Company of Los Angeles, California, who are wholesale chemists, handle their orders with such a system. Orders received by mail or telephone are routed to the company's tabulating department where cards are picked from a library of pre-punched cards for each order and after being gang-punched with customer account numbers, etc, are sent the warehouse.



A Game to Improve Sales Executives

If you want to take decisions without burning your fingers this is for you: it should teach you business strategy to apply in real situations

THE American Management Association first introduced top management to general business games—(dry exercises which simulate, with the help of a mathematical model, business conditions). That was four years ago in 1956. Since that time there has been increasing interest in developing games and simulations for specific aspects of business activity and even for specific industry. Concentrating on particular functions of business operations provides an opportunity to explore and acquire practice in decision making.

Such simulations have proved effective educational devices. Providing executives with conditions that approximate as closely as possible to 'the real thing' without the actual involvement of factories, capital and staff, and, of course, without the hazard of disastrous results, they do demon-

strate the problems of decision-making under stress and uncertainty, and impress the importance of balanced policy-making. Once the 'mathematical model' and associated computer program have been developed, the simulation programs can be used without taking up much computer time; the training is achieved by means of the analyses and discussions about decisions taken and the evaluation of results, rather than in the use of the computer.

Last year the Remington Rand Univac Division of Sperry Rand Corporation developed a sales-management and marketing decision-making simulation or game, involving the use of the large-scale Univac system. The model has been used in the Division of Marketing of Columbia University's Graduate School of Business, and for one-day sessions at the Institute of Management Sciences and the National Sales Executives' Graduate School of Sales Management and Marketing at Syracuse University.

Columbia's course is described here, since it is more representative of an effective company training program. The other sessions involved so-called 'continuous play', where a year or eighteen months of decision-making must be compressed in the one day. Groups must be fairly close to the computer to provide 15-minute scoring at regular 30-minute intervals, and where, of course, the computer time must be specifically allocated for the time of the sessions. Because of the time element, fewer factors can enter the decision-making than are possible under the spaced-out 'discontinuous' mode employed at Columbia.

At Columbia, with sessions a week apart, the actual computer time of 15 minutes between sessions presents no scheduling problem. Moreover, the participants are given a much greater opportunity to analyse results and confer on actions to be taken. Some of the team members have been known to spend as much as five hours between classes to arrive at proposed policy. (The weekly intervals represented a month of actual time under the rules of the simulation.)

SIMULATION IN ACTION

It is emphasised that the objective is to secure insight into and practice in *decision-making*, rather than to develop specific quantitative results. Accordingly, teams are told they are in business to sell a product that is barely described.

At an initial briefing session, the 'rules of the game', given below, are outlined. The fact that the game is programmed on a computer is not stressed, for the participants are not to get the impression that they are to try to beat some machine, or that some programming trick is involved. All that the computer program does is to simulate as far as is practicable the inter-action of all relevant factors after the decisions for a particular period are fed into it. As far as the participants are concerned, the results given in the operating reports reflect what has happened outside in the market-place, not inside a computer.

Participants are divided into teams (three to six members a team), each representing a company marketing an essentially similar product in competition with the other teams (companies), in three regional markets—East, South and West. There can be four to ten competing companies (in the Columbia course there were eight). Each company starts with two general assumptions:

1. They have been called upon to undertake the marketing of a relatively new product which has not been properly exploited.
2. A number of competitors have introduced similar products into the same market.

Each team begins operations with a company which is identical with all others in general status and resources. It then attempts to have its company show the largest net profit at the end of a given number of operating periods. The simulated markets contain adequate realism to produce reasonable performance results from sensible decisions. Long-range planning is rewarded, while hand-to-mouth operation generally produces a lower profit return.

In this simulation the activity of all competitors is *inter-acting*; that is, the operations and decisions of one company affect the performance of all other companies. Thus, the sales performance of a given company depends not only on its own decisions, but also on the decisions made simultaneously by its competitors. The precise effect of any single decision, therefore, is as difficult to analyse as in a real marketing environment.

The management of each company makes policy and operating decisions in the areas of:

SALES PERSONNEL ADMINISTRATION
PRODUCT PRICING
ADVERTISING AND SALES PROMOTION EXPENDITURES
STOCK MANAGEMENT

The decisions of each company are evaluate[d] simultaneously with those of all competitor[s] terms of certain 'built-in' characteristics o[f]

REMINGTON RAND UNIVAC
SALES MANAGEMENT AND MARKETING SIMULATION
COLUMBIA UNIVERSITY SPRING 1959

ACE PRODUCTS PERIOD 05
NET $71,193
ACCUM. NET $201,925

ACTIVITY REPORT	EASTERN REGION TOTAL $	EASTERN REGION UNIT	SOUTHERN REGION TOTAL $	SOUTHERN REGION UNIT	WESTERN REGION TOTAL $	WESTERN REGION UNIT
OPENING INVENTORY	2,000	27.00	2,223	27.04	1,800	27.00
SALES	1,926		1,471		1,746	
STOCK-OUTS						
RECEIVED LAST DAY	2,200	27.00	1,600	27.00	2,200	27.00
OPENING NEW MONTH	2,274	27.00	2,352	27.01	2,254	27.00
COST ANALYSIS ON SALES OF—	1,926 UNITS		1,471 UNITS		1,746 UNITS	
SALES REVENUE	121,338	63.00	97,086	66.00	113,490	65.00
COST OF GOODS SOLD	52,002	27.00	39,776	27.04	47,142	27.00
SHIPPING COSTS	4,400	2.28	3,200	2.17	4,400	2.52
CARRYING COSTS 4%	2,160	1.12	2,404	1.63	1,944	1.11
ADVERTISING COSTS						
LOCAL	7,500	3.89	12,500	8.49	7,500	4.29
NATIONAL—PRO RATA	6,666	3.46	6,666	4.53	6,666	3.81
MARKET RESEARCH	600	.31	600	.40	600	.34
PERSONNEL CHARGES	0	0	2,000	1.35	2,000	1.14
SALARIES AND EXP.	4,950	2.57	5,400	3.67	4,500	2.57
TOTAL COMMISSIONS	12,134	6.30	10,679	7.25	12,484	7.15
NET PROFIT—MONTH	30,951	16.07	13,930	9.47	26,312	15.07
PERSONNEL REPORT	PERS.	AVG. EFF.	PERS.	AVG. EFF.	PERS.	AVG. EFF.
OPENING TOTAL	11	7.9	12	6.9	10	7.7
IN TRAINING	0	—	1	—	1	—
ACTIVE SELLING	11	—	11	—	9	—
NEW HIRES	0	—	1	1.0	1	1.0
RESIGNATIONS	0	—	0	—	0	—
TERMINATIONS	0	—	0	—	0	—
TRANSFERS IN	0	—	0	—	0	—
TRANSFERS OUT	0	—	0	—	0	—
OPENING NEW MONTH	11	8.1	13	7.1	11	7.7
COMMISSION RATE	10%		11%		11%	
ADVERTISING BUDGETED NEXT MONTH						
LOCAL	2,500		7,500		2,500	
NATIONAL	4,444		4,444		4,444	
PERFORMANCE						
SHARE OF MARKET	13.5%		13.8%		13.0%	
TOTAL MARKET	14,264 UNITS		10,656 UNITS		13,432 UNITS	

market. The results of these decisions are shown on a series of monthly reports which include information on inventory, sales personnel, sales activity, profit and loss, and general competitive status.

On the basis of a pre-established policy, and guided by this monthly report, decisions are then made by each team for the next operating period. The full cycle of decision-making, computer processing, and printing of the necessary reports requires approximately 30-45 minutes per period (month).

The share of the market achieved by each company is determined by the inter-action of many elements. These elements combine to create two major determinants of sales: product marketability and the effectiveness of the sales force. In effect these inter-relationships which are programmed into the computer, constitute the rules of the game.

OPERATING REPORTS

Results are shown on operating reports for each period. These monthly operating reports for each company are presented in six logical sections. A sample operating report is shown on page 28 and elaborated upon below.

1. *Activity Report*
   a. Opening Inventory — A carry over of the closing inventory of the preceding period less any units committed to trans-shipment to another region. The on-hand quantity and the factory unit cost of the goods are indicated.
   b. Sales — The number of units ordered and delivered during the month.
   c. Stock-outs — The number of units ordered for which sales could not be made because of a run-out of stock-on-hand. The sum of sales and stock-outs is a measure of the market achieved in that region.
   d. Received Last Day — Goods ordered from the factory or trans-shipped from another region during a period are not available to meet orders during that period. This is indicated by showing goods as received on the last day of the month.
   e. Opening New Month — The closing inventory reflecting the balance of on hand, sales and receipts together with a new average factory cost.

2. *Cost Analysis*
   a. Sales Revenue — Gross receipts from actual sales at the specified unit selling price.
   b. Cost of Goods Sold — Factory cost of goods are not charged until units are actually sold.
   c. Shipping Costs — Transportation costs for goods received during the month from the factory or trans-shipped from another region.
   d. Carrying Cost — Computed as a given percentage of factory cost of the average inventory held during the month.
   e. Advertising Costs — The charge during the current month for both local and pro-rated national advertising and sales promotion campaigns.
   f. Market Research — The pro-rated charge for additional market information requested.
   g. Personnel Charges — The total cost for all hirings, unsuccessful attempts to hire, transferring, firing, or training of sales personnel.
   h. Salaries and Expenses — The total cost for salaries and office expenses.
   i. Net Profit — The balance of sales receipts less all costs enumerated.

3. *Personnel Report*
   a. Opening Total — The total number of company salesmen in the region and the estimated efficiency of the staff as indicated by a numerical index.
   b. In Training — The number of salesmen committed to training during this period.
   c. Active Selling — The balance of the staff. How effective they are is indicated by the efficiency index under the opening total.
   d. New Hires — Includes both trained and untrained men hired. Additions to the staff become effective on the last day of the period requested.
   e. Resignations — This will be the first indication to a company that a salesman has been hired away from them. Resignations are effective on the last day of the period.
   f. Terminations — Terminations result only from decisions to sack salesmen, and become effective on the last day of the period.
   g. Transfers — As a result of a decision to transfer a salesman, the man will continue to sell at the source region until the last day of the period in which the decision is made. He becomes available to the destination region as of the first day of the following period.
   h. Opening New Month — Balance of salesmen at the close of the period with a re-computed average efficiency.

4. *Advertising Report* — The amount of money already committed to both local and national advertising and sales promotion for the next period.

5. *Performance* — The total market for this period for each region and the percentage share achieved by this company.

6. *Competitive Information* — A report of commonly known or easily obtained information about competitors is made available every period. This report on all participating companies reflects only the size of each regional sales force, the selling price in each region and a note as to whether there has been advertising in each region. Quarterly a report is issued on net profit to date for all companies.

PRODUCT MARKETABILITY

The marketability or attractiveness of a particular company's product depends on several factors, all under control of sales management:

1. Advertising and sales promotion
2. Selling price
3. Price stability
4. Customer service record

1. *Advertising and Sales Promotion*—Each company makes decisions monthly on total expenditures for advertising and sales promotion. Funds are allocated between short or longer-range campaigns, and between national and local advertising. Severely unbalanced allocations (local *versus* national) are penalised. The general effect of increases in advertising expenditures is to *increase* the share of market at a *decreasing* rate.

2. *Price*—The attractiveness of the product varies inversely with the price. The effect of price becomes increasingly erratic beyond a board

average range. It is possible for a company to price itself out of a given market area.

3. *Price Stability*—Changes in price are reflected in a change in marketability. The market, however, is inert (and suspicious) to a degree such that the increase in marketability resulting from a *decrease* in price requires several periods to be fully felt. An *increase* in price meets somewhat higher resistance during the first month of the increase than it does in later months.

4. *Customer Service*—This factor is a direct reflection of a company's record in inventory control. Major stockouts (occasions when the product is out-of-stock) in a region will, in addition to resulting in loss of sales, reduce the service factor and have a cumulatively adverse effect on demand for the company's product in that region. Minor stockouts (less than 5–10 percent of orders) result only in a loss of sales.

SALES FORCE EFFECTIVENESS

Each firm starts with from eight to 14 salesmen in each region. The effectiveness of these sales groups depends upon three factors:

1. The financial motivation or incentive provided to salesmen.
2. The average ability of the regional sales force.
3. The number of men actively selling in a given region.

1. *Motivation*—Each company decides quarterly on the commission rates for the sales force in each region during the next three months. These rates, once established, must be maintained for three months. In addition to affecting sales force effectiveness, the commission rate has an obvious bearing on salesmen's earnings, and is thus a consideration in whether a competitive company may hire personnel away from a given firm.

2. *Salesmen's Ability*—The average ability of a regional sales force depends upon training and experience. Experience is reflected by monthly additions to the group's efficiency index. Training for any individual salesman also raises the group's average efficiency. Company managers decide monthly whether training expenditures are to be made. Information on the cost of the one-month training program is provided.

3. *Number of Active Salesmen*—The size of the sales force is determined by monthly decisions regarding hiring, firing, and regional transfers. The number of active salesmen is the total sales group less the number assigned to a training program. Additional salesmen may be obtained from two sources: from a competitor (experienced) or from the street (unexperienced). In general, the incentive for inter-company transfer is monetary insofar as the salesmen are concerned (the new company must show greater earnings for each salesman than his current company does). For the hiring company, the prospective recruit must represent an improvement in efficiency over the average of the current staff. If these criteria are not met, the transfer will not take place and the company searching for a trained man will be charged for an unsuccessful search.

TOTAL MARKET AND SHARE OF MARKET

A demand forecast for the type of product which each company and its competitors market is provided at the start of the game. This forecast reflects a certain seasonality, and also indicates expected regional proportions of this potential market. The demands indicated, however, are predicated on a given price range and a specific level of advertising, sales promotion, and selling effort. Actual sales will vary from the forecast as a result of general price changes and varying advertising and selling effort by all companies. The market is dynamic in another respect. The relative influence of price, advertising, staff ability, etc, in determining the actual market will vary as a function of time.

The share of each regional market achieved by each company is determined by weighing the product marketability and the sales force effectiveness of each competitor. Costs incurred to achieve that share of the market and the revenue derived from resulting sales provide the information from which profit and loss are calculated.

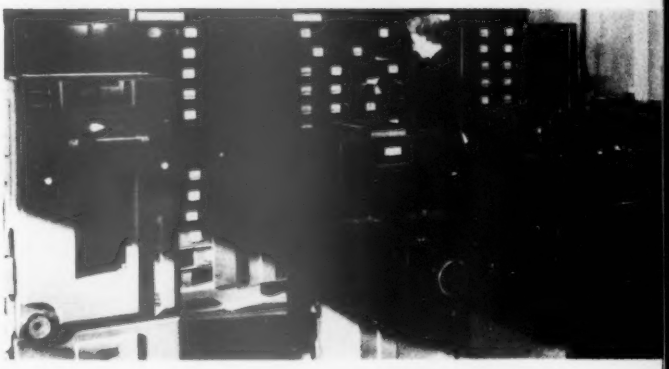
MARKET RESEARCH REPORTS

In addition to the above information, each company has the opportunity to buy detailed market research information about the standing and performance of its competitors. Several types of information are available.

A decision must be made to buy none, part of, or all of the market information available. This information is presented as an additional report not received unless purchased. Costs of the various reports are given before the excercise:

1. *Personnel Status Report*—A region-by-region and competitor-by-competitor report of total sales force size, number of active salesmen and an estimated efficiency classification.
2. *Advertising and Sales Promotion Report*—A listing of the local and national advertising expenditures of each competitor given in broad categories.
3. *Performance Report*—The approximate percentage share of the actual market achieved by each competitor, and also the approximate number of units sold with an asterisk noting any company which is known to have had a major stock-out during the period.

Producing Renewal Documents



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Phœnix Assurance have a centralised system for producing renewal and receipt documents as a run-of-the-mill operation

A N Salmon *

MUCH of the work connected with the running of an insurance company is necessarily of a routine nature. In my company discussions on ways and means of mechanising routine tasks started while the last war was still in progress.

At that time consideration was centred largely on the administrative changes which modernisation would entail, leaving the discussion of practical details until it would be known what equipment would become available. It is perhaps indicative of the constant progress made by the data processing industry that a satisfactory solution to one particular problem has only now been found, 10 years after the first steps were initiated.

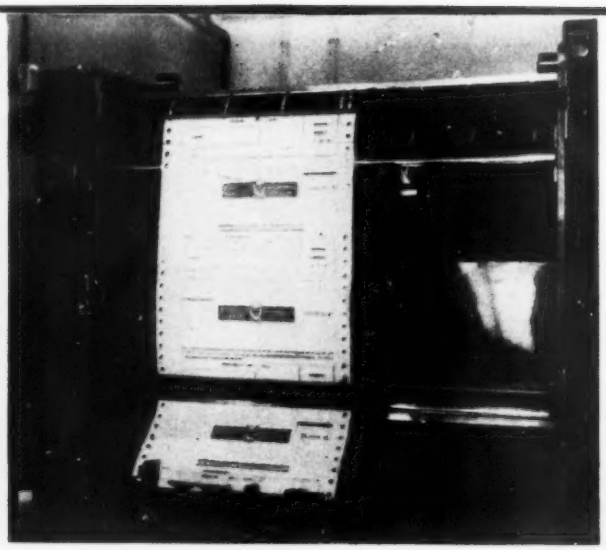
The Records Office is the department which deals with the renewal documents sent out regularly to policy holders and it may be of interest to review the progress of its reorganisation, since it is fairly typical of much of the work of insurance companies.

Before and during the war, most of the administrative work on policies was carried out by the branch office through which a given policy was taken out. Records were arranged chronologically, so that renewal notices could be sent at the appropriate times. Under this manual method renewal notices and receipts were produced simultaneously.

A survey of the equipment then available (to mechanise this work) showed that it should be possible to cope with the entire material—even allowing for considerable expansion—from all branch offices in the monthly intervals between the preparation of renewal documents. To equip all branch offices with their own machinery for doing this work would have meant unnecessary duplication of capital expenditure and labour, so the first step was to arrange for renewal documents to be prepared at a central office.

The production of monthly renewal documents

* Records Office Superintendent, Phœnix Assurance Co Ltd.



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having been centralised and mechanised, renewal and receipt forms continue to be processed simultaneously. The information required is contained on punched cards and address plates, which are prepared from details supplied by the branch offices of the company as soon as a policy becomes effective.

The punched cards are identified by the policy number, and contain such details as the name of the insured, code number of branch and agent, type of policy, sum insured, premium and various other data of an administrative nature. The cards are filed in drawers in the cabinets shown in Figure 1. (See page 31). The cards are divided over the cabinets in numerical order, but within each cabinet are sorted into the drawers chronologically, so that at any given date all the drawers for the appropriate month, extracted from all cabinets, contain all the cards of policies due for renewal.

LISTS, NOTICES AND RECEIPTS

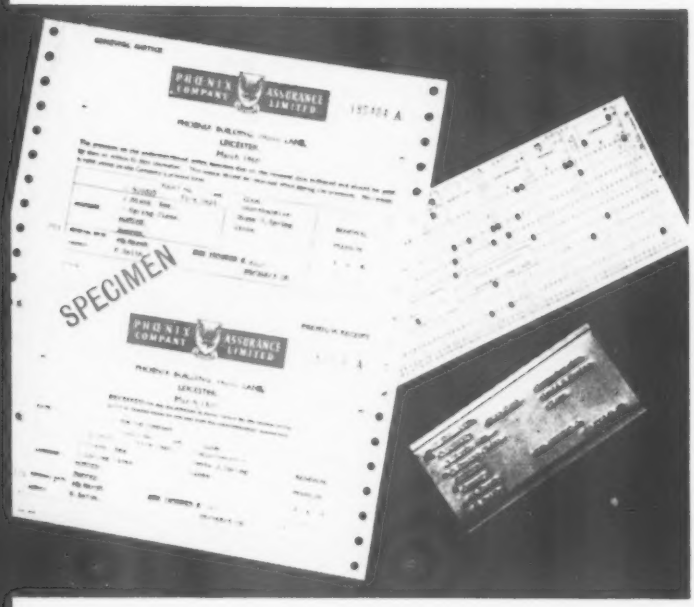
The system now works very smoothly. Every month the appropriate drawers are withdrawn and the punched cards fed through the Powers-Samas interpolator shown in Figure 1 to enable agents' name cards to be inserted, so that when these are printed out, each list is headed by the agent concerned.

All the cards are then fed to a Powers-Samas tabulator (see Figure 2 on page 31), on which the renewal lists are prepared. These lists show policy number, premium, commission and certain other internal information, arranged first by branches, and within each branch by agents.

After extracting the agents' name cards the cards are next fed to a second tabulator which, by means of a double sensing device, prints out the combined renewal and receipt forms. Each form is five inches deep and so laid out that the printed-out information occupies the same position on both, as can be seen in Figure 3. The over-all grand total of each branch must be agreed with the corresponding total obtained from the printing of the renewal lists.

The renewal notice and receipt stationery and Powers-Samas cards are then transferred to the embossed plates department, where the address plates are kept. The stack of cards is inserted into the Powers-Samas sensing unit shown at the left of Figure 4, which is electrically linked to a comparator unit in the Bradma addressing machine, the corresponding address plates are placed on the addressing machine and the stack of continuous renewal and receipt forms threaded into the machine.

Each plate, in addition to the policy holder's name and address, carries the policy number, the type and class of policy, renewal date and agency, as well as the words ' Sum insured ' where appropriate. It is also provided with an identification key, which by means of the comparator unit in the addressing machine enables agreement to be obtained between plate and card as to the last three numerals of the policy number. Only if agreement takes place is the address plate fed to the printing position and superimposed on the renewal notice and receipt forms. As a further safeguard, the second tabulator also prints the last



5

6

three policy numbers in the left margin which must, of course, agree with the number over-printed by the plate.

The punched card, address plate and combined renewal and receipt forms for a fictitious policy holder are shown in Figure 5. After separation into double-forms as shown, the renewal lists (from the first tabulator), together with the appropriate double-forms, are sent to the branch offices.

REGISTER AND SEPARATION

As stated above, the completed pairs of forms must be separated. This is best done as they come off the addressing machine, which is not itself equipped with a power-feed for continuous stationery. The feed must be extremely accurate, since a lot of information is contained on the plate of limited depth, which therefore allows of no margin of error in achieving register with the print on the forms. (The words 'Sum insured,' for instance, from the address plate must line up accurately with the figure printed out on the tabulator.)

The twin problems of accurate feed and accurate separation presented a stumbling block for several years and were eventually solved by coupling each of the two Bradma addressing machines with a Type P1001 electronic guillotine supplied by A J Catlin Ltd.

With this guillotine stacked or reeled stationery is normally placed into a recess at the front of the base of the machine, threaded over the table and deposited after cutting on a hinged delivery table at the rear. Feed is by means of pin-studded belts which engage with the sprocket holes in the margins of the forms. The margins are trimmed off by two edge trimmers, one on either side, whose position is adjustable. (The pin feed and trimmers are shown in Figure 6.)

The cutting impulse for the solenoid-operated guillotine blade is derived from the addressing machine. The equipment is arranged so that every time an address plate is printed the guillotine feeds the stationery forward by exactly five inches. After every second printing operation an impulse from the addressing machine actuates the guillotine blades, thus causing a double-form to be cut. With a maximum cutting rate of up to 8,000 cuts per hour, the guillotine can easily cope with the output from the addressing machine.

Since the guillotine cuts several forms in front of that being printed, the distance between the printing unit and the blades must be very accurately maintained.

Names and Notes by Robot

Carrying Coals

ORDINARILY, it would be an almost impossible task to check on transport arrangements evolved through tradition and considerable experience. But with the help of a computer the West Midland Gas Board have found a practical way to do just this.

In fact, over a period of three years the Board have promoted exercises to study the most efficient way of transporting coal from the pits to the gasworks.

Preliminary discussions between Board officers and representatives led the chairman of the Board to commission a pilot exercise, considering that it would be worth a few hundred pounds (the cost of computing) to test the soundness of the system of coal allocation, which was costing some £2½ million a year in rail costs alone.

The problem was by no means simple. Should the exercise cover delivered cost of coal, or merely transportation? Should it cover coals delivered by road as well as railborne coals? Was the necessary information available? These and similar decisions had to be taken, and the answer to the last question, in fact, decided the other issues.

There were about 3,000 separate rail charges, and also as many possible road charges, and some road costs were not only unobtainable but also not strictly comparable with railway rates. It was finally decided, therefore, to limit the pilot exercise to rail transport, and this resolved itself into the problem of routing 47,000 tons of coal each week between 55 collieries and 31 gasworks.

So this became a joint venture by the Board's coal and transport manager, its chief accountant and the computer experts. The coal and transport staff obtained the full schedule of nearly 1,500 railway rates by writing to and visiting the London terminals of several railway regions. The accountants prepared this and the other necessary data for the machine and experts prepared the program.

The exercise was carried out on an IBM 650 computer in 1957. Altogether about 13 hours of computing time were taken up and it was not until 150 solutions had been examined by the machine that one where projected costs were less than actual costs was found. The minimum cost or optimum solution was reached at the 215th iteration and at that point there were several optimum solutions differing from each other in greater or lesser degrees.

The optimum result showed possible savings of about £1,430 a week or £70,000 in a year. While this was a very satisfactory result, it represented a saving of less than 3 percent of total cost which showed that the previous methods of allocation, based on tradition and experience, were 97 percent as good as the machine could provide.

The Board receives its coal supplies from North Staffordshire, Yorkshire, Nottingham and Derby and North Wales coalfields. Prior to nationalisation, in a free market, coal from North Staffs went to Birmingham, Wolverhampton and Walsall, but the organisation set up by the Board to control its fuel supplies decided to place the whole of its North Staffs allocation of coals to the gasworks situated in the North Staffs area.

It was also discovered, due to special circumstances, that it was, in fact, cheaper to bring Yorkshire coal into Birmingham than to the gasworks situated anything up to 50 miles north of Birmingham.

This policy was subsequently confirmed by the survey carried out on the electronic computer.

However, the first result from the computer was not the final solution. The exercise had been commissioned primarily on a pilot basis to reduce costs and some technical aspects had been disregarded. The alternative optimum solutions

were examined exhaustively by a small committee headed by the deputy chairman of the Board and comprising the coal and transport manager, the area chief engineer and area chief chemist. Objections were found to some parts of the solutions on the grounds of high sulphur content of coals, unsuitability of residual coke, and similar technical matters. With these objections raised, precautions were taken to overcome them in the second exercise, which was already under consideration and the results of which were to be used to re-route the Board's coal supplies.

The second computer program ran for eight hours, and the final solution showed an annual saving of £45,000. The selected solution was put into effect and, apart from modifications due to changes in coals and requirements at works, has formed the basic pattern ever since. A third computer exercise, to ensure that the alterations had not affected the main program, was carried out in 1959 as a check.

The Board now plans to study the question again by bringing the road-borne coals into the problem. This will involve, in all, 63,000 tons of coal transported each week by rail and road from 64 pit-heads to 45 works. The cost involved is over £3 million a year, and two or three qualities of coal from each pit are being received.

This will, therefore, be a bigger exercise than the previous ones, but it should not cost much more to carry out. An example of how computer techniques are advancing is given by the Board's experience. In the case of the first exercise, which was carried out soon after the IBM 650 had arrived in this country (in fact, it was run in its temporary home in London with the machine still standing on the bases of the delivery boxes) the time taken was 13 hours and the cost of the computer service was just under £500, covering the hire of the machine, punching of cards and printing of results. The second exercise took only eight hours and cost £300. In 1959 the exercise was run on an IBM 704—just as an experiment—and it was solved in 12 minutes.

Common Denominator for Global Comparisons

TODAY one of the big firms in the wax shoe polish business is Chiswick Products Ltd, a member of the Reckitt and Colman Holdings Group.

It makes Nugget, the world's biggest selling shoe polish, Cherry Blossom and a range of household polishes. With factories in a number of overseas countries, it markets in practically every country of the free world. It buys widely—waxes, stains and aromatic essences as well as material for its tins and card packaging which are also made and printed at Chiswick.

An interesting aspect of production is the use of standard hours. In effect there are one main production department, making and packing the polishes, and three ancillary departments—tinbox making, tin printing and cardbox making—producing the packaging.

A major production problem since the war has been the difficulty of obtaining workers to meet fluctuating sales demand. To overcome it, the company have set out to maintain a steady level of production throughout the year in all departments by controlled stockpiling.

Sales estimating, which governs the degree of control needed, is complicated. Apart from seasonal variations, expanding export markets—more people abroad are wearing shoes—plus the development of new lines and the impetus of television advertising can shatter the best of crystal balls.

Obviously the company had to be kept up to date with deviations from estimated sales that would affect the labour or overall stock levels and ideally the information would give time to implement decisions without the need for emergency measures.

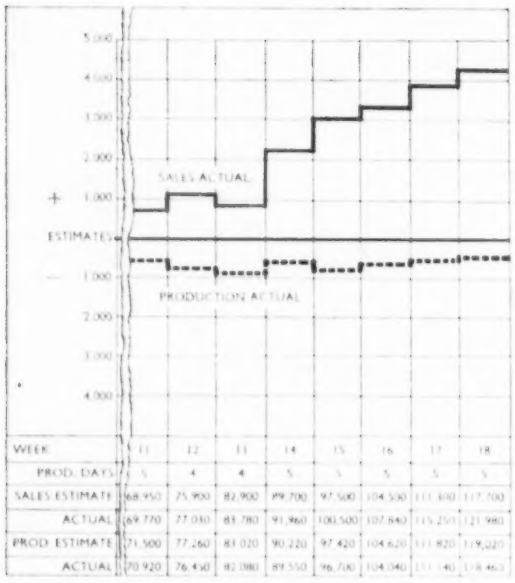
'To provide such a quick reference we had to tackle another problem, the company's wide variety of lines and ancillary packaging products—a dozen or more different colours, sizes, specifications and packs under one brand name, for example,' said Mr J W Helling of the planning department. 'We had to find a common denominator to permit global comparisons. Sterling values could not be used since they bear little or no relationship to labour requirements.

'We decided to use the labour content of each line, measured in *standard hours*. For this, initial information was available for each line since the wages payments are based on measured times.'

The annual sales estimate is produced and converted into standard hours in cumulative weekly periods. The annual production required in standard hours of work is divided by the number of working days available in the year and this figure is then loaded weekly, on the number of available working days, as a cumulative figure throughout the year. Actual sales and production on a weekly cumulative basis are then recorded against the estimates. Differences between actual and estimated sales and production are then graphed above or below a straight line. The difference between the actual sales deviation from estimate and the actual production deviation is the movement of stock from the estimated level.

The figure shows an example of the control chart (in standard hours).

Here a steep upward deviation in actual sales was caused by a decision—taken after the sales



WEEK	11	12	13	14	15	16	17	18
PROD. DAYS	5	4	4	5	5	5	5	5
SALES ESTIMATE	68,950	75,900	82,900	89,700	97,500	104,530	111,330	117,700
ACTUAL	69,770	77,030	83,780	91,960	100,500	107,840	115,250	121,980
PROD. ESTIMATE	71,500	77,260	83,020	90,220	97,420	104,620	111,820	119,020
ACTUAL	70,920	76,430	82,080	89,550	96,700	104,040	111,140	118,463

EXAMPLE OF SALES/PRODUCTION DEVIATION FROM ESTIMATE CONTROL CHART (IN STANDARD HOURS)

estimates were prepared—to launch a sales and advertising campaign, basically on one product. The control chart showed that the stock level before this rise—stocks being at peak in winter—could cope with the extra sales if the labour force was fully made up during the staggered holiday period which was to follow. The labour force was maintained by employing students on holiday.

Pilot Venture Nearly Over

WITHIN the next few months rayon and textile manufacturers Courtaulds Ltd will receive a second National-Elliott 405 system in their Coventry offices.

Since December last year Courtaulds have been running a small (and compensatingly cheap) 405 system for payroll and bonus calculations – but this was really a pilot venture designed to enable the company to test for themselves the potentialities of electronic data processing and to try their hand developing skills in the new techniques.

The second machine is to be a very much larger system (and worth two to three times the first one) and will take on a wider range of work.

For a time the two machines will run in parallel but eventually the smaller system will be disposed of, the new complex will take over its work (without the need to rewrite programs) and, equipped with large-volume magnetic files, it will be put to work on an extensive stock control procedure.

COURSES AND CONFERENCES

13-17 June
Executive Course—General Appreciation Course on Computers
Organised by Leo Computers Ltd
Fee 25 guineas
Venue Leo Computers Ltd, Hartree House, 151a-159a Queensway, London, W2

13-24 June
Course on the Pegasus Computer
Organised by Ferranti Ltd
Fee £30
Venue Newman Street, London
Enquiries to Mrs J A Hickman, Ferranti Ltd, 41 Portland Place, London, W1

13 June-1 July
Computer Course on the Emidec 1100
Organised by EMI Electronics Ltd
Fee 50 guineas

16 June
Communication Seminar
Organised by The British Institute of Management
Venue London
Enquiries to The Conference Secretary, British Institute of Management, 80 Fetter Lane, London, EC4

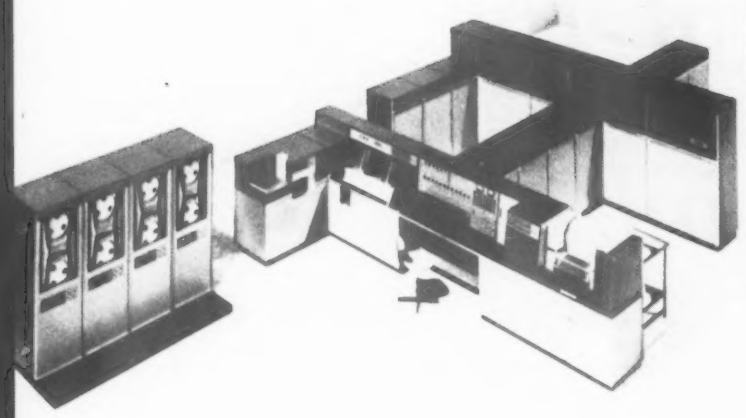
27 June-29 July
Programming Course for Leo II
Organised by Leo Computers Ltd
Fee 110 guineas
Venue Hartree House, 151a-159a Queensway, London, W2

4 July
Programming Course on the Stantec Zebra Computer—Simple Code
Organised by Standard Telephones & Cables Ltd
Fee 15 guineas
Venue Newport
Enquiries to Standard Telephones & Cables Ltd, Corporation Road, Newport, Mon.

4-8 July
Second Annual Conference of the British Computer Society
Organised by The British Computer Society
Venue Harrogate
Enquiries to Miss D E Pilling, Electronic Computing Laboratory, The University, Leeds, 2

4-22 July
Course on the Emidec 2400 Computer
Organised by EMI Electronics Ltd
Fee 50 guineas
Venue Hayes, Middx.

11 July
Programming Course on the Stantec Zebra Computer—normal code
Organised by Standard Telephones & Cables Ltd
Fee 50 guineas
Venue Newport
Enquiries to Standard Telephones & Cables Ltd, Corporation Road, Newport, Mon.



New ICT Contender

THE new transistorised ICT computer — designated as the 1301 — is an entirely new design. Envisaged primarily as a business machine, it is aimed at interesting a wide range of industrial and commercial organisations from those whose needs comprise a punched card data processing system upwards.

One feature of the computer is that it is possible to expand the basic system or to increase the operating speed after it has been installed.

The basic machine uses 80-column punched cards and incorporates a card reader, a line printer, a card punch, a core store with capacity for 400 words and a drum store with a 12,000-word capacity. Core store can be increased to 2,000 words in steps of 400, and drum storage — by adding up to seven drums — can be increased to 96,000 words.

Eight tape transports can be linked up to the machine, and where magnetic tape working is required there is an option of two tape systems:

1. A standard system with an input feed rate of 22,500 decimal digits a second.
2. A high performance system with a 90,000 decimal digit a second feed rate.

A single address system of programming is used and a comprehensive auto-code is available.

The basic computer can be housed in a room of 500 square feet, and as there are no valves in its make-up, no special air conditioning is required, except when tape units are included in the system.

SYSTEM DETAILS

Data Storage: The word length is 12 decimal digits, with alphabetical characters represented by two digits. Immediate access core store can vary from 400 to 2,000 words in capacity. Each drum holds 12,000 in 60 peripheral channels of 200 words each, each channel being divided into 20 decades of 10 words. Transfers can be effected either in decades or channels, and any number of decades up to 20 can be transferred in one instruction.

With a drum rotating speed of 5,240 rpm, average access time for a decade transfer is 5.7 milliseconds, to which must be added 0.57 milliseconds for the actual transfer.

Arithmetic Unit: The computer operates in serial-parallel code. Addition speed is 25 microseconds and average multiplication speed 170 microseconds.

Card Reader: Newly designed reader operates at 600 cards a minute.

Line Printer: The printer operates at speeds of up to 600 lines a minute (there are 120 print positions and 50 characters per print position). Printing is entirely program-controlled.

Card Punch: This will punch at the rate of 100 a minute. Information punched out is automatically checked with that which originated the operation.

Features of the AEI 1010 Computer

Described by

Peter Tainsh

Associated Electrical Industries Ltd

IT is now widely accepted that the exclusive use of a computer for single commercial applications, such as a payroll or inventory control, implies that the real problem of conversion to an automatic data processing system has not been solved. In many cases, the effect is merely to carry out more rapidly precisely the same functions already carried out manually. Consequently it becomes difficult to justify the installation of a computer on economic grounds alone.

When considering the installation of a computer for commercial or industrial data processing applications, the potential user should examine not only his immediate requirements during the first one or two years after installation, but, always with his eyes on the future, plan from the start ultimately to convert all possible clerical operations to an integrated ADP system.

This means that the computer chosen must be sufficiently flexible, so that the initial installation can be easily expanded by the addition of new ancillary units to meet new requirements, often perhaps unforeseen at the time of installation. Ideally, such extensions to the system should be accomplished without any alterations to the existing computer.

Expansions to fully integrated data processing usually means that the computer must be able to process a large volume of input and output data which can only be satisfactorily handled if it has the following facilities:

- A variety of input, output and auxiliary storage systems to deal with a variety of applications.
- Autonomous operation of these systems. (That is, they should all be capable of operating simultaneously.)
- Parallel programming, so that processing on two or more applications may take place at the same time.

Recent developments in the logical design of electronic digital computers have now made it possible to provide these facilities, all of which are available on the AEI 1010 Data Processing System which is now being manufactured in Manchester at AEI's Trafford Park Factory.

DEVELOPING THE 1010

Early in 1957, the team of design and development electronic engineers which had built the first British transistorised computer—the Metrovick 950—was augmented and work was started on a fast, fully transistorised, parallel-arithmetic computer.

It was known then that it was possible to design a central computing unit with a ferrite core working store, which could transfer data and operate upon these hundreds of times faster than the fastest known types of input and output devices, and some fifty times faster than auxiliary and secondary storage devices such as magnetic drums and magnetic tapes. But it was considered necessary that the 1010 should be capable of operating a large number of ancillary units simultaneously, and to

continue computing while transfers between these ancillary units and the working store were in progress, if the demands of fully integrated data processing systems were to be met.

This requirement for autonomous operation was satisfied by the development of a novel system of sharing time on the working store which takes advantage of the high speeds of computation and transfer operations which could be achieved.

The time-sharing equipment can control at any one time up to 32 items of peripheral equipment, of any manufacture, connected to the computer through separate control units and inexpensive buffer stores. The connection to the computing unit is through multiple data *highways* which are common to all control units. It is therefore possible to expand a medium-sized initial installation merely by connecting the required new peripheral units to the highways via plug and socket connections.

The high speeds of internal arithmetic and transfer operations in the 1010 allow a useful volume of data processing to take place within the time to complete reading and writing operations on input and output equipment, or transfer of data to and from magnetic tapes and drums. This is necessary for the successful operation of the parallel programming facilities.

CONTROLLING ANCILLARY EQUIPMENT

Data Scanning Equipment

In the AEI 1010 computer the simultaneous operations of peripheral units is achieved by means of a 'data scanning' or 'buffer search' system which shares the time of the working store between the program control unit and those ancillary units which need to transfer data into or out of the store.

Each ancillary unit operates at its own speed independently of the computer, transferring a block of pre-determined size, one word at a time, through its single-word buffer store (or in certain special cases, two one-word buffers).

Once the instruction which initiates the block transfer has been given, the computer is free to carry out further instructions in the program, while the transfer of the block is executed word by word. The standard block size is 32 words, but variable block facilities are available for certain peripheral units.

The Two Control Units

In order that word transfers from or to ancillary equipment may take place simultaneously with the execution of program steps, the computer contains two control units called the long and short controls.

When engaged in a long order (a multiplication or division for example, which may take up to 250 microseconds), the two controls run simultaneously as soon as the order has finished with the working store, the long control finishing the arithmetical function, while the short control deals with any transfers of data which require attention at that time.

Data Rate

The computer takes 13 microseconds to transfer a word in either direction from each buffer store, so that in general all 32 buffer stores and the associated peripheral units will be safely attended to even when they are all operating simultaneously.

However, it is quite obvious that there is a limit to the total data rate associated with any data processing system based on the internal operating speed of the computer.

Since the computer can transfer one word every 13 microseconds, there is an upper limit to the data handling rate of 77,000 words, or over half-a-million characters, per second. If the peripheral equipment attached to the computer were to exceed this peak data rate when all are operating together, there would be some loss of data, and faults would be indicated on some of the units.

The peak data rate of most peripheral units is low, as can be seen from the table below:

UNIT	PEAK DATA RATE
Fast paper tape reader (1,000 characters/sec.)	166 words/sec.
Punched card reader (370 cards/min.	90 words/sec.
Paper tape punch (300 characters/sec.)	50 words/sec.
Card punch (100 cards/min.)	40 words/sec.
Enquiry typewriter	10 words/sec.
Samastronic line printer (300 lines/min.)	100 words/sec.

The console of the AEI system

Auxiliary storage units are faster. For example

UNIT	PEAK DATA RATE
Magnetic drums	3,200 words/sec.
Decca tape units	1,500 words/sec.
Ampex tape units	5,500 words/sec.

All these are peak data rates. The average rates are lower, first, because the peak rate is not always maintained throughout the time to transfer a block of data, and secondly because the units are not always in continuous operation, but rest between blocks as dictated by the program.

From the figures quoted it can be seen that a system controlling 32 peripheral units of all kinds, excepting Ampex tape units and magnetic drums, cannot exceed the peak data rate of 77,000 words per second.

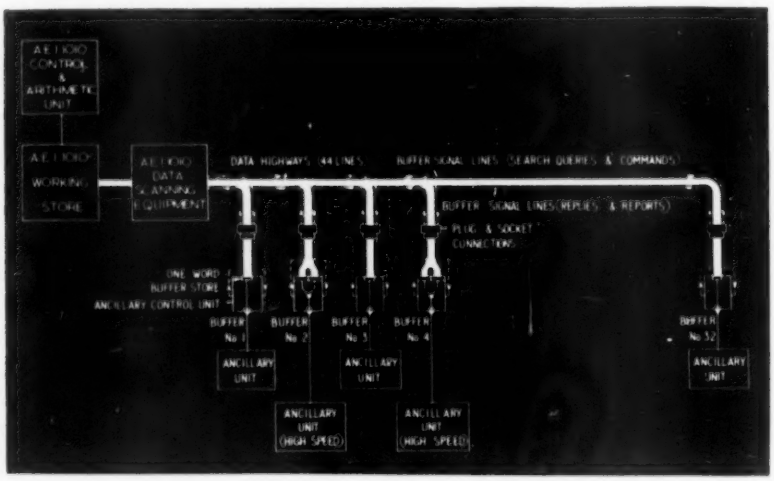
There must however be some method of limiting the simultaneous operation of the latter very fast units if faultless operation is to be achieved. The demands for magnetic drums is usually small (*ie.* from 1 to 4 in typical installations) and no other limitation is required for these units. But very large systems may require many high speed magnetic tape units to be under computer control although it is rarely, if ever required to operate them all simultaneously.

In such systems, a special device will inhibit the initiation of simultaneous transfers from or to more than a predetermined number of tape decks until one or more of the current transfers have been completed. Thus, in the rare cases where a program calls for more than the limited number of simultaneous transfers from magnetic tapes, there will be a delay of up to 5 milliseconds before the additional units can be started up.

ANCILLARY EQUIPMENT

Some examples of the ancillary equipment now being specified for AEI 1010 Data Processing Systems are:—

- Magnetic Core Store Unit with a capacity of 2,048 or 4,096 words each of 44 binary digits.
- AEI Type 972 Magnetic Drum Store with a capacity of 8,192 words, each of 44 binary digits with a transfer time, for a 32 word block, of 10 milliseconds.
- AEI CRPI High Speed Paper Tape Reader, reading 5, 6, 7 or 8-hole punched paper tape at 1,000 characters per second.
- Elliott High Speed Card Reader, reading 65 or 80 column punched cards at 370 cards per minute.
- ICT Type 582 Card Punch, punching 80 column cards at 100 cards per minute.
- Creed Model 25 Reperforator, punching paper tape at 33 characters per second.
- Creed Type 3,000 Paper Tape Punch, operating at 300 characters per second.
- Decca Type 3000 Twin Magnetic Tape Deck, with 120 bits per inch of tape and a tape running speed of 104 inches per second. 10,000 blocks of data are contained on 2,400 feet of magnetic tape.



Schematic diagram shows how autonomous operation is achieved by the system's data scanning equipment

- Ampex FR-300 Tape Deck, with 315 bits per inch of tape and a tape running speed of 150 inches per second. 30,000 blocks of data are contained on 3,600 feet of magnetic tape.
- ICT Samastronic Line Printer operating at 300 lines per minute.
- Rank Xeronic Printer, operating at 3,000 lines per minute.

PARALLEL PROGRAMMING

A computer system which can control a large number of peripheral units cannot be expected to employ them all simultaneously on one job, except in very rare cases. It must, therefore, be designed to carry out a number of jobs at one time if it is to make the best use of its powers.

Parallel programming facilities have, therefore, been made available, through a 'program switch,' which consists of a special sequence of machine instructions held in the working store, and this not only permits time-sharing between programs themselves, but will also allow an urgent or 'crash' program to be given overriding priority and to interrupt another.

The program switch allocates space in the working store and backing stores. It also decides whether a new routine has storage and ancillary equipment requirements compatible with the routines already under computer control, before it is accepted. Two-way communications are provided between the operator and the computer by a direct keyboard machine, which may be a teleprinter or Flexowriter.

CENTRAL COMPUTING UNIT

The main computing store of the 1010 consists of a ferrite core matrix, which has a read-re-write cycle time of eight and a half microseconds and an access time when reading of three and a half microseconds. Access is to all 44 binary digits of a word plus 4 parity digits simultaneously. Each word may contain the equivalent of a 13-digit decimal number expressed in binary form, a group of coded alpha-numeric characters or two instructions, which are separately addressable.

The working store may contain either 2,048 or 4,096 words, and a 2,048 word store may be increased to 4,096 words by the replacement of plug-in units if the increase in work load demands the additional storage.

All transfers of data between the computer registers and all arithmetical and logical operations are carried out on all 44 digits simultaneously, resulting in some very fast operation times.

Medium instructions, such as addition and subtraction, take 18 microseconds while short instructions, used extensively in data processing, take 13 microseconds. On an average, some 70,000 data processing operations can be performed every second.

Auxiliary storage is available on magnetic drums, each of which can contain 8,192 words. These may be used as stores for alternative or emergency programs, or as a second level of storage where this is necessary. The average access time to any drum address is 10 milliseconds, and the time taken to complete a block transfer to or from the drum is a further 10 milliseconds. Additional drums may be added at any time to increase the auxiliary storage and the maximum number of drums which may be installed will vary, depending on the number and types of other ancillary units in use.

ANCILLARY CORE STORAGE

Additional rapid access magnetic core storage may be coupled to the AEI 1010 computer through one of the 32 ancillary unit buffer channels. The size of this core store can range from a single unit of 2,048 words or 4,096 words up to as many as 2^{22} (or over 4 million) such units.

A single transfer instruction will call up a block of one to 2,048 words from a selected storage unit.

The buffer channel to which the ancillary core storage system is connected is allocated priority next lowest to the program control unit in the central computing unit.

This ensures that transfers from any other ancillary units are not affected and are always safely attended to. Whenever a block transfer from an ancillary core storage unit is initiated, that unit will take up all the spare time available in the computer until the transfer from one ancillary core store has been completed. This means that no program step can be started during that period. Since the last program step must have been the instruction to initiate the transfer from the core store, it is possible to read the new program (or data) into the appropriate place in the working store where it may be acted on immediately. For a block of 32 words, the extra time taken to obey each instruction held in ancillary core storage (since it must first be extracted and transferred to the working store) is between 7 and 8 microseconds. This extra time will be less if larger blocks are transferred.

AUTOMATIC CHECKING FACILITIES

Parity checks and similar tests are made to test the accuracy of data read from the working store, ancillary core store, magnetic drum, and magnetic tape stores and wherever possible on the standard input and output equipment. The design of some types of input and output devices does not always allow for such checks to be made and in these

cases, program checks or special codes are used.

There is a parity check on each group of 11 digits read from working store. Two of these groups of eleven digits make up one instruction and four groups make up one computer word. Checks are also made on the accuracy of the results of arithmetic operations.

On each block transferred from magnetic tape to the working store there is a transverse parity circuit to check the correctness of each character, and in addition, a longitudinal parity counter counts up the digits along each track and performs a sum check at the end of each block transfer. Failure to transfer correctly or completely is indicated, and automatic action is taken by a section of the program switch to stop the magnetic tape, rewind and re-read this block. In the writing operation, newly recorded blocks are checked after writing by a separate checking station.

If a parity failure or a fault occurs on any ancillary equipment, or if stationery has run out etc, an indication is always given to the operator, and information is not lost. The computer will, wherever possible, take automatic action as a result of a parity failure.

In addition there are facilities for stopping a program on any given instruction for checking purposes.

COMPUTER REGISTERS

The two main accumulators of the computer are referred to as M and D. They are each 44 binary digits in length, the most significant digit in both being used as a sign digit. In addition to being used separately, M and D are used together as an 87 binary-digit register for certain double length operations.

The contents of any register in the ferrite core store can be added to, transferred to, or subtracted from, both M and D. Conversely the contents of M can be added to or subtracted from the contents of any store register. In multiplication, the answer is contained in the combined register MD. In division, the dividend is in the combined register MD, the quotient in D and the remainder in M. There is a group of functions which multiply and divide the contents of M, D and MD by powers of 2 and a special register (the E register) of 44 binary digits, holds the multiplier in accumulative multiplication.

There are eight B registers each of 13 binary digits in length. B(1) to B(7) are used in the conventional way for counting and address modification. B(0) is a special automatic modification register used to provide relative addressing facilities by a double modification of addresses in conjunction with the conventional B registers.

This facility will allow the contents of the B(0) register to be added to the instruction during the access time of the other B register. Thus the contents of the B register specified can be added to the previous sum, so that the two B modifications are carried out within the instruction time.

This double modification makes it possible for programs and sub-routines to be placed anywhere in the working store and obeyed without changing the addresses in the program or sub-routines. This is a great simplification for the programmer, who no longer has to consider absolute addresses and can write his sub-routines in such a form that they can be incorporated in any place in any program and be correctly obeyed.

PROGRAMMING

The 1010 data processing system has a wide range of instructions designed to give maximum flexibility in the use of the system in varying applications. There are three main groups of functions: those which perform arithmetic; those which do 'housekeeping' or logic; and those concerned with the control of ancillary units. A considerable number of jump instructions, which break the sequential obedience of orders by the computer, are also available in the 1010 code.

Each routine must have, as part of its first block, an 'information' block which holds the details which the program switch requires when allocating storage and ancillary units.

This information is basically:

(1) How much working storage is required.

(2) How much backing storage is required.

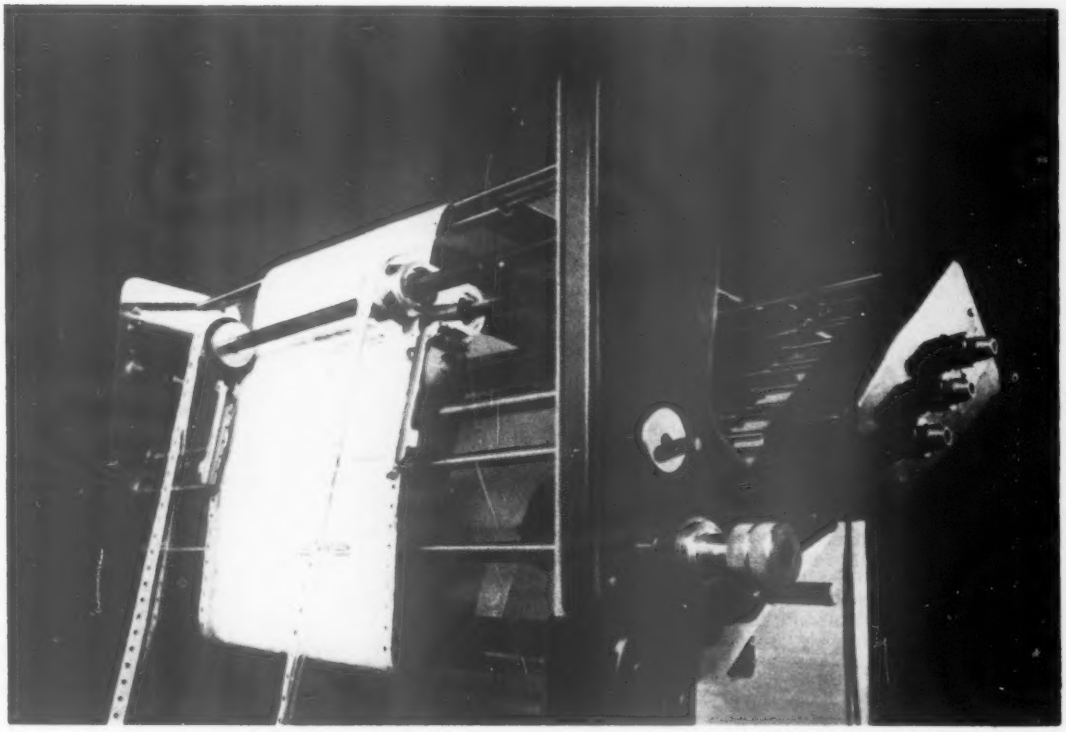
(3) What peripheral units are required.

There is a procedure for initiating a program which is to be run in parallel with a program already in operation in the computer, making use of the facilities offered by the program switch.

AVAILABILITY AND COST

The first production model of the AEI 1010 computer is now undergoing its final tests in the computer department of the AEI Electronic Apparatus Division in Trafford Park, Manchester, and will undergo trials in the new Manchester Computer Centre with various items of peripheral equipment throughout this year.

The system is being offered by the manufacturers for sale or rental in 1961, and a medium-sized installation controlling between six and eight items of peripheral equipment will cost between £150,000 and £200,000 for direct purchase, or a rental of £40,000 to £50,000 per annum (including full maintenance) depending on the ancillary equipment specified.



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WHAT'S NEW

in systems, services and equipment

A Versatile Teaching Machine

AN automatic teaching machine which can instruct anyone in virtually, it is claimed, any subject, ranging from bridge or golf to complex electronic problems or abstruse mathematical formulæ, was recently introduced in Britain.

Named the Auto-Tutor, the machine has been developed in the United States by US Industries Inc but will be shortly manufactured in Britain. Initially, its most useful role will probably be in large industrial and military training programmes.

The Auto-Tutor presents questions on any chosen subject to the student. If he answers correctly, the machine congratulates him and sets a further task. If the student is wrong, the machine tells him how and why and encourages him to tackle the problem again, after giving him further information. The Auto-Tutor can assess real knowledge and rate of progress so that the true educational level of the student is revealed.

Advantages are that the tutor advances a student at a rate determined by his own ability, records progress of the trainee and provides a record of the individual's approach and reasoning process.

The machine is, in principle, an automated 'reader' that locates and presents any selected subject image or images when a number is punched on its keyboard.

The student controls it by pressing combinations of buttons, which total 40, according to which answer he chooses. Each alternative answer shows a new image number alongside it. The tutor automatically locates and presents the new image. Thus the microfilm may be ordered to go forward or backward to any one of 9,999 numbers corresponding to images on the microfilm.

By a combination of still and 'moving' pictures, the machine can instruct not only by photographed printed material, but by means of actual demonstrations in motion, teaching industrial techniques, experimental methods, chemistry, physics or any other subject.

The tutor will cost in the region of between £1,000 and £4,000. There will be standard material available for the machines, and special courses can also be prepared. The machines will also be offered on a rental basis.

US Industries Inc (Great Britain) Ltd.,
New Bond Street House,
1-5 New Bond Street,
London, W1.

US Industries' Tutor is worked quite simply by pushing buttons

ADP for Everyman

ELECTRONIC and punched card data processing procedures are available to any business today at remarkably moderate cost. There is nothing to buy except time at a computer or punched card service bureau where the rental charge includes the advice of experts in every type of application.

A Service for Everyone is, therefore, an apt title for a 16-page booklet recently published by IBM. Simply written, it describes in a strictly down-to-earth way how the ordinary business can use these technical services. Commercial work, operational research and scientific work are dealt with under separate headings. In each case an indication of costs is given and the reader is shown what results can be expected with correctly planned data processing techniques.
IBM (United Kingdom) Ltd.,
101 Wigmore Street,
London, W1.

Quick Wiring System for Card Installations

A DEVICE which simplifies the plugboard procedure required in most tabulating machine systems and installations has recently been developed. Called 'Novano,' it is a pre-wired plaque system reducing the number of 'fixed' boards required and, in some applications, obviating their need entirely.

It also reduces the number of 'basic' control panels used in most installations.

The system is flexible, accurate, convenient in use, and easily stored.

The process of plugboard preparation in so many punched card installations involves the accurate insertion, by highly skilled operators, of hundreds of individual leads, each in its appointed place, and this task must be repeated every time a change of machine application is demanded. For this reason 'fixed' boards (control panels plugged up to conform with one application only) are frequently encountered, and these add to already existing problems of space, storage, and cost.

The Novano system consists of a series of clear plastic plaques, shaped and pierced to correspond precisely with various control

panels involved. For use with these plaques, Novano provides pre-wired connector assemblies — similar to the orthodox 'pluggable connector,' but ending in paired tubes instead of plugs. These assemblies are plugged into the plaque by means of a simple hand tool, and in accordance with the appropriate function chart of diagram. The Novano plaque thus pre-wired is offered up to the control panel with which it is to be used, and contact is effected by rubber-headed pins, an operation that can be performed by completely unskilled staff. Once the selected machine function has been completed the plaque is unpinned in a few moments and may be easily stored for use again the next time the same application is required.

Punched Card Accessories Ltd.
Abbey House,
Victoria Street,
London, SW1.

Feasibility Study

RECENTLY published, a booklet entitled *A Feasibility Study for Distribution* collects together the findings made by Lamson Paragon during investigations carried out at the request of their customers.

Among the topics discussed are the various methods of form preparation, form design and the advantages of a well-designed invoice despatch system that allows all phases of the operation to be linked together.

The booklet is intended as a guide to hard-pressed managements and indicates the many time- and money-saving possibilities that are open to them.

Beginning with a discussion of the meaning of the phrase *feasibility study*, it carries on under such headings as 'The Advantage of Seeing the Job from the Outside,' 'The Design of Forms as an Aid to Efficiency' and 'Form Preparation in Horizontal Sequence.' Also practicable systems are described, varying from those adaptable to simple typewriter techniques to punched card tabulation.

Lamson Paragon Ltd.
Paragon Works,
London, E16.

Education in Business Machines

AN educational division has been formed by Bulmers (Calculators) Ltd to co-operate with the teaching profession and to provide, free of charge, machine operating tuition and technical and advisory services. Dr E Kerr, Head of the Department of Mathematics, the Royal Technical College, Salford, has been appointed as consultant to this division.

Substantial reductions in prices and rental terms are offered to educational establishments wishing to install Bulmers or Friden equipment. Special consideration will be given to co-operation in short experimental courses for trying out equipment.

Bulmers (Calculators) Ltd.
47-51 Worship Street,
London, EC2.

(CONTINUED ON PAGE 46)

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BISHOPSGATE 3336

Office Copier

XEROGRAPHY is a well-known method of producing high-quality master printing plates by electrical photography for use with offset litho or duplicating machines and as such is established in many print departments.

First office copier to incorporate the advantages of xerography is now being produced. Called the Xerox 914, the machine will copy anything written, typed, printed or drawn, from originals in any colour; the finished result is always black and white.

The original can be anything from a letter to a bound book. Ordinary paper is used and because of its 'magic eye' camera, the Xerox 914 requires no adjustments of exposure. It is, therefore, impossible for an operator to make an error of judgment. He, or she, simply puts the document in position, dials the number of copies wanted and pushes the 'print' button.

With this completely dry process the prints emerge, at the rate of six a minute, ready for use. They are permanent and all copies are of equally high quality. When the machine has made the number of copies ordered it automatically shuts itself off.

In common with other manufacturers of highly complex office equipment, the makers of the 914 (pronounced 'nine-fourteen' to denote largest finished copy size, in inches) have devised a rental plan to bring their machine to a wide range of users.

The customer will pay a basic rental of £30 a month and on each copy over 2,000 he will be charged 3d. If 100 copies are made per day, the cost per copy is just under 4½d. For 250 copies a day this drops to less than 4d. each.

Rank-Xerox Ltd.
33-34 Mortimer Street,
London, W1.

Collates Pages

WHEREVER there is a problem of gathering together printed or duplicated material in set sequence, the 650 Accra-Feed Collator will provide an answer.

Loading is by suction feed from an input which has a capacity of 5,000 sheets of paper. The operation is automatic and the extraction of collated sets from the five-compartment rotary drum is electronically controlled to guard against the errors normally associated with such work. An electronic 'eye' prevents sheets being missed in sets, a photographic scanner detects and eliminates blank sheets—each sheet is 'read' as it is fed to the drum compartment. A double sheet eliminator automatically detects and rejects doubles. An electronic shut-off stops the machine when the job is completed and an automatic sheet and book counter accurately controls the number of completed books.

Model 650 can handle sheets ranging from 4 inches wide by 6 inches long up to 11 inches wide by 14 inches long.

Addressograph-Multigraph Ltd.
29 Kingsway,
London, WC2.

Checks on Dropouts

THE MSS Recording Company have made a study of the performance of data processing tape in relation to the occurrence of dropouts. They have found that an analysis of the results of a specially designed system of dropout tests will enable the performance of a particular batch of tapes to be stated for a very wide range of conditions of use. The information enables the computer time lost in error correction to be estimated and its cost to be weighed against the cost of any proposed grade of tape.

The tests also produce information which is of great value to the designer and the user of data processing systems since it enables them to predict the effect of changes in pulse packing density or dropout level on the performance of their system.

The equipment developed for carrying out these tests was on view at the IEA Exhibition at Olympia last month.

MSS Recording Co Ltd.
Poyle Trading Estate,
Colnbrook,
Slough,
Bucks.

Compact Photocopier

A PHOTOCOPIER called the Verifax 'Bantam' is so simple to use that junior members of the firm can quickly learn to operate the few simple controls, freeing typists and senior members of the staff for more important duties.

It is inexpensive enough to bring it well within the reach of even the smallest business and also enables larger concerns to have a copier in every department.

The Bantam will make five, accurate, permanent black and white copies of any document up to 8½ inches by 11 inches in size, in one minute, whether the original be typed, written or drawn in any colour.

Non-photographic paper is used and copies are produced dry and ready for use. Price £42.

Kodak Ltd (Recordak Division),
Victoria Road,
Ruislip,
Middx.

No skill or intelligence is required to operate Rank's Xerox 914 copier.

CLASSIFIED ADVERTISEMENTS

RATES: APPOINTMENTS VACANT, 3s. 6d. per line (minimum 3 lines), 40s. per display panel inch. APPOINTMENTS WANTED, 3s. per line, 35s. per display panel inch. Box No. charge, 1s. extra. Address advertisements to The Classified Advertisements Manager, "Automatic Data Processing," 109-119 Waterloo Road, London, S.E.1. Tel.: WATerloo 3388 (Ext. 32).

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MORE OPPORTUNITIES

WITH 'PHASE TWO' APPOINTMENTS FOR

SENIOR ENGINEERS

The second series of appointments are now to be made for Britain's BMEWS—the £43,000,000 Ballistic Missile Early Warning System to begin construction shortly on Fylingdales Moor, Yorkshire.

These appointments call for Senior Engineers to supervise the installation, commissioning and initial operation of BMEWS systems and equipment. To men of far-above-average qualifications this outstanding project offers careers of a variety and scope without equal in recent years . . . vitally important work of extreme interest . . . and salaries to match the calibre of the men we require. They will have every opportunity to attain key senior posts which will progressively develop during the emplacement, installation and commissioning stages.

All applicants must be of British nationality, and able to show a specific background of practical experience sufficient to qualify them for a nine to twelve month period of initiation and training at the RCA Missile and Surface Radar Division at Moorestown, New Jersey, U.S.A., when salaries will be supplemented by living allowances.

Subsequent work will be on the Site and or at RCA Great Britain's Head Office at Sunbury-on-Thames.

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DATA TAKE-OFF ENGINEER *(ref. BTS 18/L).*

To train as leader in BMEWS Tracking Radar Data Take-off sub-systems through installation and check-out, leading to supervision of all sub-systems equipment and initial operation.

Qualifications: *Good degree and a broad practical understanding of electronic systems, plus at least 5 years' experience in basic electronic equipment, followed by recent experience in data processing computers.*

SUB-SYSTEM ENGINEER *(ref. BTS 25/L).*

To train as leader in the Check and Automatic Monitoring side of BMEWS Tracking Radar and Data Take-off facilities throughout installation and check-out, with subsequent supervision of the sub-system's initial operation.

Qualifications: *As for Data Take-off Engineer, but with additional working knowledge of digital and analogue computers.*

LETTER FOR THE FUTURE **Give us the fullest possible information about yourself—your training and experience, education and age—in a letter addressed to the Appointments Director, quoting the reference number of the post of major interest to you.**

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This is a challenging appointment with a vigorous and expanding company offering attractive prospects and benefits, including the use of a company motor car.

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Successful applicants will be required to work largely without supervision on programmes for the recently installed Emidec 1100 computer, covering both commercial and scientific activities.

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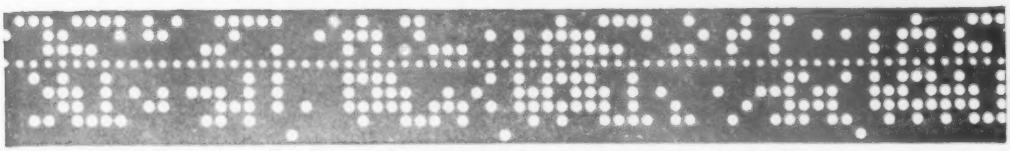
FRIDEN FLEXOWRITER



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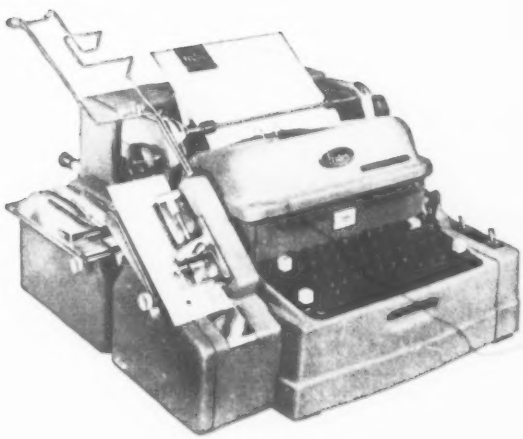

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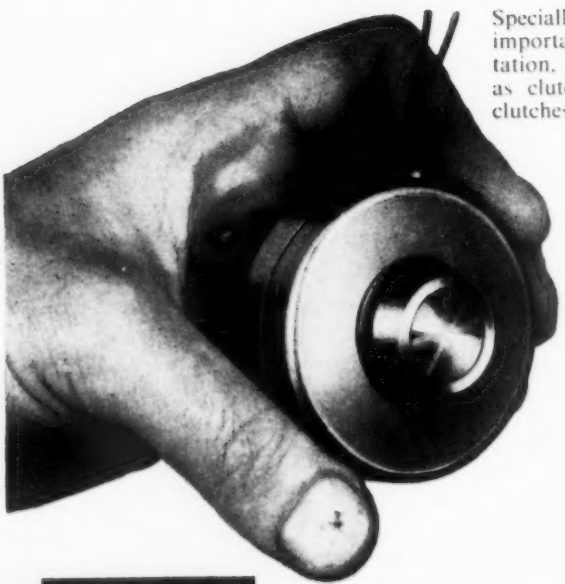

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